Alternatives to Pesticides in Tropical Countries

Sustainable Agriculture – Food Securtiy with Food Safety

A. T. Dudani

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VIGYAN PRASAR

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Acknowledgements

This book is result of my accidental entry in the area of alternatives to pesticides after I attended a meeting organised by the Department of Science & Technology for the panel on use of science & technology for protecting consumer interests. This led to the preparation of a Status Report on the subject which is considered as a landmark by many in driving pointed attention to the dangers of pesticides to human health and the environment. This followed my entering the Voluntary Health Association of India and joining an ongoing campaign with the International Organisation Consumer Union, Penang. There has been no looking back ever since as many more groups and individuals entered the fray.

During 1992, the Department of Science and Technology gave a grant to the author for writing this book under the Retired Scientists scheme. I profusely thank the DST for their initial grant which made this book writing possible. My debt of gratitude goes to Vigyan Prasar people who wasted no time in deciding to bring out the book which is now in your hands for evaluation. The book has been updated till end 1998 and has over 780 references.

I gratefully thank each of the authors (and the organisations where they worked) and the publications where from I have quoted and drawn heavily.

However I must acknowledge that I have drawn special inspiration from the highly motivated and brilliant groups working at the Pesticides Trust, London and the Food Commission, London, IIED, London, Pesticides Action Network, North America, Beyond Pesticides Coalition, Washington, Consumers Union, New York, PAN, Penang, Pesticide Policy Project of GTZ Hannover, Greenpeace amongst many others.

This apart I have drawn special sustenance from the dedicated groups at the University of California, Santa Cruz and Davis and Consortium for Sustainable Agriculture Research and Education, University of Wisconsin Madison. However, the

very base of the sustainable agriculture movement rests on the historic work of the US Department of Agriculture and the National Research Council, Washington DC, which forms the bedrock of a movement away from pesticides. Another group as valuable has been the CIAT, Cali, Colombia. In writing about the newer challenges my thanks are due to RAFI, Canada, Union of Concerned Scientists, Washington DC and Grain, Barcelona, Spain. To all these my sincere thanks.

Back home, my visits to Bhaskar Save's Farm, Valsad and that of Narayan Reddy at Bangalore have convinced me that safe alternatives agriculture is possible with hard work and belief, despite existence of many vested interests, a situation which is not helped by indifference of many of our official agencies.

Lastly, I wish to place on record the painstaking incisive and excellent editorial work of the late Mr. Norman Dantas.

Special thanks are also due to Punam Thapliyal for laborious work on the hand written manuscript with all its cuttings, over-writings, corrections and sometimes hard-to-read hand-writings using the computer time provided by the DST.

Finally I would like to dedicate this work to the Report of the World Commission on Environment and Development, *Our Common Future* and its indefatigable, untiring Chairperson Gro Harlem Brundtland the former Prime Minister of Norway and the present Director General, World Health Organisation, Geneva (genera. doc. msw)

Dr. A. T. Dudani

Foreword

I have had a close look at the just completed book of A. T. Dudani entitled Alternatives to Pesticides in Tropical Countries Sustainable Agriculture, Food Security with Food Safety. The subject matter is both fascinating and timely considering that while on one hand the Governments are pushed into producing more food to meet people's needs, on the other, there is mounting evidence of the harm rather than good caused by the use of pesticides. This is evident from the ever-increasing number of farmers worldwide turning to organic farming to satisfy the mounting needs of the consumers for safe food. While the world is turning away in a big way from pesticides – the most poisonous chemicals ever devised by man – it appears that powerful vested interests of the pesticide manufacturers' lobby have sold the idea to the policy and decision-makers that without the use of pesticides, there will be shortfall in food production thereby resulting in hunger and death. In the absence of well-informed information base as to how the world is tackling the situation despite this starvation bogey, and lack of a strong R&D database and support, this view tends to prevail with the policy-and decision-makers.

Dr. Dudani, a known scientist, was responsible for producing in 1987 the first ever Status report on the subject on behalf of the Department of Science and Technology. This benchmark reference document has led to the present book. The book is divided into 14 Chapters and highlights the dangers of pesticides with specific examples from India and across the globe. The Chapter 'Why Opposition to the Pesticides' presents documentary evidence on the subject. Of special interest is the recent research by world-renowned scientists which shows that many of these pesticides are mimicking the role of human estrogens and leading to wrong development of human functions. There is also the problem of resistance acquired by pests, which has ended up making pesticides ineffective just as in the case of antibiotics.

The book also highlights the new dangers created by the mammoth multinationals in developing new genetically engineered foods which rely only on a particular type of pesticides, leading to monopolistic situations. The recent new development of Terminator technology, which means that the seeds will not germinate unless you purchase new ones, is rather far-reaching and will strike at the root of farmers' economy and well-being. Dr. Dudani has also brought out effectively how the pesticide use is going to affect our biodiversity

and future well-being. The author has not rested only in fault finding, but has drawn extensively from the world experience to show that there are excellent alternatives of various kinds including reduction in pesticide use eventually leading to farming without pesticides. He has cited many down-to-earth examples both in this country and outside in support of his thesis.

Dr. Dudani's painstaking work, and forward looking approach is bound to generate rethinking both here and in other countries especially in the Third World . The book has come not a day too late and I can only congratulate the author and publisher, Vigyan Prasar, for the same.

Maneka Gandhi,
Minister of State for
Social Justice and Empowerment
and an Environmentalist.

Introduction

The author is a distinguished scientist and research scholar who has served in various capacities with CSIR, ICAR, ICMR has also worked with FAO. He has made useful contribution to science through his papers and research work. His latest work is this book on "Alternatives to Pesticides in Tropical Countries".

The voluminous book is a testimony to the enormous research work that he has done on the subject and also to the depth and range of his knowledge in this field. The book is of great relevance to agriculture based economies in the tropical countries and should prove to be equally informative and stimulating to the scientists, researchers and agronomists.

The use of pesticides all over the world has increased manifold in recent times due to the discovery of new and exotic varieties of pests, weeds and plant diseases. While the useful role of pesticides in containing plant diseases and in preventing crop failure hardly needs emphasis, there is need to exercise caution in excessive and indiscriminate use of pesticides. Farmers all over the world have learnt it the hard way, through trial and experience, that heavy doses of pesticides is not always the most judicious way of pest control. This book on "Alternatives to Pesticides in Tropical Countries" could not have, therefore, come at a more opportune time.

It was Gro Harlem Brundtland who first showed the possible path to sustainable development in her "Our Common Future". Earlier, it was Rachel Carson who had highlighted the various dangers arising from the use of pesticides-movement that is now ushering in agriculture sans pesticides. In this direction "Our Stolen Future", by Theo Colborn and her associates has further made it necessary to move away from pesticides.

Dr. Dudani has evidently drawn on experience from around the world on the trends of organic farming to highlight the negative aspects of indiscriminate use of pesticides, and has cogently argued that farming without chemicals is feasible and sustainable. The emphasis in the book is on

pragmatic use of new technologies for sustainable development as has been successfully demonstrated by a large number of farmers in advanced agro-economies of Europe, USA and elsewhere.

The Book has over 780 references from all over the world, and I am sure this wealth of knowledge would prove useful to our students, teachers, researchers and agronomists alike in understanding this ingenious way of promoting sustainable development, food safety and food security.

Sompal
Minister of State for Agriculture
Government of India

VIGYAN PRASAR
An Introduction

Vigyan Prasar (VP) was set up by the Department of Science and Technology, Government of India, as an autonomous registered Society in 1989 for taking up large-scale science popularisation tasks. Its broad objectives may be summarised as follows:

> To undertake, aid, promote, guide and co-ordinate efforts in popularisation of science and inculcation of scientific temper among the people and to increase the knowledge, awareness and interest about science and technology among all segments of the society.
>
> To provide and promote effective linkages on a continuing basis among various scientific institutions, agencies, educational and academic bodies, laboratories, museums, industry, trade and other organisations for effective exchange and dissemination of S&T information.
>
> To undertake development of materials — audio, visual, audio-visual and printed — methods and modes of communication, so as to enable the masses to better understand, appreciate and comprehend abstract scientific principles and practices.
>
> To organise research work, courses, workshops, seminars, symposia, training programmes, fairs, exhibitions, film-shows, popular discussions, street plays, quizzes, song-dance-dramas etc., in furtherance of the objectives of the Society.

After its establishment Vigyan Prasar remained dormant for a few years. Only in 1994 some activities could be taken up in right earnest. One among the first few programmes initiated by Vigyan Prasar was the 'Ready-to-Print' Science Page project. The idea was to prepare a well laid-out newspaper-size page with one or two features and several smaller items on scientific and technological (S&T) developments taking place in India, appropriately supported with photographs, illustrations, graphics etc., and to supply it to newspapers to carry as it is. Initially, such pages in Hindi and English were planned for release once a month. Subsequently, a children's page, science pages in other major Indian languages and a feature packet service were also added. Today, these pages are being carried once or twice a month by more than 30 editions of some 20 newspapers spread all over the country. In fact, today Vigyan Prasar's are the largest circulated science pages in the country. The combined print order of all these newspapers exceeds 2.5 million copies. These pages have led to fresh demands for enhanced science coverage in other newspapers.

Vigyan Prasar's publications programme is gradually taking The

shape. A number of important series has been launched; some more are planned. The first major English publication brought out by Vigyan Prasar, viz., *"Memoirs of Ruchi Ram Sahni: Pioneer of Science Popularisation in Punjab,"* under its series on Pioneer Science Popularisers in Pre-Independence India has generated positive awareness among science communicators and enthused researchers about the need to unearth other such personalities in other parts of the country. Already names of a number of individuals who did pioneering work in the field of science popularisation in pre-Independence India have come to light.

Popular science classics written by Great Masters in the past, which have inspired generations of students of science, are no longer seen in the hands of our younger generation. This is not because these books have gone out of context, but because they are no longer available. Vigyan Prasar under its Popular Science Classics series intends to reprint these books and bring them out in low-priced affordable editions so that more and more children can have them. Already two such classics (Michael Faraday's *Chemical History of a Candle* and C.V. Boys' *Soap Bubbles And the Forces Which Mould Them)* and their different language versions viz., Marathi, Tamil and Hindi have also been brought out. George Gamow's "One,Two, Three...Infinity: Facts and Speculations of Science" has also been translated into Hindi.

Inspired by the focal theme for the National Science Day-1995, viz., 'Science for Health', Vigyan Prasar initiated a Health Series. Under it publications on all common diseases, along with possible management of their curative and preventive aspects would be brought out. The first three titles on *Sexually Transmitted Diseases, Asthma and Jaundice,* have already been released. More titles including books in other languages are also coming out.

Under its series of Monographs on India's Scientific Heritage Vigyan Prasar intends to bring out publications on specific science and technology areas in which India's contributions have stood the test of time, as also have made an impact on modern-day science. The first monograph in the series, *'The Rustless Wonder: A Study of the Iron Pillar at Delhi'* was released on 30 January 1997. The second volume *'Where Gods Come Alive: A Study of the South Indian Bronze Icons '* is in the press and would come out shortly.

Some of the other publications brought out by Vigyan Prasar are *My Friend Mr Leakey*, & *Everything Has a History* by J.B.S. Haldane; *Development and Valuation of Urban Properties*, by P.K. Ratho, *Alternatives to Pesticides in Tropical Countries* by A.T. Dudani.

A new series on Environmental Hotspots was launched by Vigyan Prasar recently. The first volume brought out under the series is on Tehri Hydro-Electric Project and Narmada Valley Project.

Total Solar Eclipse of October 24, 1995, provided Vigyan Prasar a rare opportunity to organise a country-wide awareness campaign, aimed at dispelling age-old myths and superstitious beliefs related to eclipses, and to develop among people an urge to learn about their known scientific aspects. Vigyan Prasar jointly with the National Council for Science and Technology Communication (NCSTC) organised a number of activities:

i. Telescope-making workshops for students and teachers.

ii. Development and production of books, a total solar eclipse chart and an activity kit for children.

iii. Production of several video films and their telecast.

Vigyan Prasar conceptualised and implemented a novel idea for ensuring that people did come out and watch the total solar eclipse. It circulated a total solar eclipse pledge. People in thousands from all corners of the country sent in signed pledges. Many individuals and voluntary agencies got these pledges translated into regional languages on their own and distributed the same in large numbers. All this led to a chain of activities throughout the country. The efforts made by VP, NCSTC and other agencies created a situation where millions of people came out and watched the spectacular event. This was a unique experience and made Vigyan Prasar's name a household word throughout the country.

Under its audio-visual programme, Vigyan Prasar developed a set of video films and several radio programmes on the occasion of the total solar eclipse of 24 October 1995. This event-based effort was enormously satisfying for the VP family and generated a very good response from the public at large.

Vigyan Prasar has recently begun building an Information System called VIPRIS — acronym for **VI**gyan **PR**asar **I**nformation **S**ystem — to meet a long-standing demand from different quarters, particularly the science communicators, to establish a repository of background data and information on various aspects of S&T which would be accessible easily. The computerised system would be built on a modular basis, and aim to meet the information needs of science communicators of all kinds.

At this stage, under VIPRIS, we have a fortnightly clippings service, an electronic bulletin board service (BBS), weekly science news on the radio, and had two pages daily on Doordarshan's teletext service till it was closed and Several other products and services including training, generation of data bases on different subject areas etc., in the making.

The first phase of the database on " Environment & Safety Laws: Regulations & Guidance Documents " has been completed. VP launched its Homepage on the Internet on 12 September, 1996. An

online electronic popular science magazine 'ComCom', was launched soon after as part of the Homepage. The other sections of the Homepage are, About Vigyan Prasar, Daily Weather Report, Sky map of the days/month, links with other related homepage, S&T vacancies in India, News from S&T laboratories, S&T databases etc. It has provision for Hindi HTML and support for Web browsers / users to download the Hindi Plug-in and install it in their system. It has also a discussion forum with support to display and keep visitors' views.

Taking note of the growing popularity of the mulimedia mode of presentation Vigyan Prasar has launched a programme to bring out CD-ROMs on different aspects of S&T. The first two CD-ROMs, are based on its recent publication viz., The Rustless Wonder: A study of the Iron Pillar at Delhi" and "Mad, Mad, Mad Cow: An Overview of the Mad Cow Disease". The other two CD-ROMs under development are on 'Eclipses' and 'Living Space and Structures'.

A number of video programmes has also been produced. Recent ones among them have been on "Herbal petrol" and "Comets" (in connection with the coming of the comet "Hale-Bopp"). Several other programmes are under production.

Vigyan Prasar and All India Radio Bhopal jointly produced "Paryavaran Calling", a 26-part fortnightly phone-in-quiz radio serial. This programme was aimed at inculcating scientific attitude and awareness about all aspects of environment among the masses. The phone-in as well as postal winners were taken on a Nature Tour of 2-3 day's duration to tourist and environmentally important places of Madhya Pradesh. Similar kinds of programmes are to be launched with All India Radio, Chennai and Guwahati.

Vigyan Prasar has also produced audio-cassette sets of the 108-part radio serial 'Manav Ka Vikas' (jointly produced by the NCSTC and All India Radio) in 18 Indian languages.

Vigyan Prasar has initiated programme to establish science clubs in different parts of the country under the aegis of VIPNET. Efforts are also on to popularise HAM-Radio

This is not all. Vigyan Prasar does many other things. But for now this should suffice.

Narender K. Sehgal
Director
Vigyan Prasar

Chapter -1
Background

Although, agriculture is generally believed to have begun some 10,000 years back, the recorded description of insect pests is believed to have been made around 1500 BC. The Sumerians are believed to have used sulphur compounds as insecticides before 2500 BC to control insects and mites.[1]

The Chinese are credited with having developed plant pesticides for treatment of seeds and for fumigation as far back as 1200 BC. They were using chalk and wood ash for the prevention and control of indoor pests as also storage pests. There are also references to the use of mercury and arsenic compounds for the control of body lice and other pests. Later they are known to have recognised the role of natural enemies and the manipulation of planting procedures to overcome pest attacks.[2]

By 300 BC the Chinese were making use of predatory ants in the citrus orchards for the control of caterpillars and large boring beetles. The ant nests were placed in the orchards to facilitate use of bamboo runways for allowing easy transfer between infested trees. The Chinese traditional knowledge on pest control was perhaps helped by the in-depth understanding of their silkworm cultivation methods.[3]

For instance they had recognised that abundance of a particular bird species would indirectly benefit a population of aphids by eating ladybug beetles which fed on the aphids. This obviously is the basis of the biological control. In China there was also use of chemical pest control, such as the application of white arsenic to roots to protect rice transplants from pest attacks. Sulfur and copper were also employed for lice control whereas to protect sheep from parasites, pig oil was used.[4]

In Greece and Italy a variety of fumigants, oil sprays or sulfur ointments were in use. In fact the use of inorganic chemicals goes back to classical Greece or Rome. Homer has mentioned fumigant value of sulfur. Pliny the Elder has referred to the insecticidal value of arsenic and has also mentioned the use of soda or olive oil for seeds of legumes.[5]

In India perhaps the Neem tree as also other plants occupied pride of place in pest control and this spread to many Asian and African countries. It is now found in Australia and Central and South *America*. Since time immemorial Neem has been used and its Sanskrit names were "*Nimba*" and `Arishta'. From antiquity, neem has been held in high esteem by Indian folklore on account of its medicinal and insecticidal value. The earliest authentic record of its value and use in *Arthashastra*, the treatise of Kautilya on Polity, dates back to the 4th century BC. The celebrated Ayurvedic physician Susruta (1000 AD) used different parts of Neem for various medicinal purposes. [6, 7]

To this day people eat the neem leaves on New Years' Day and take bath in water in which neem leaves have been boiled. It is a common belief that the presence of a Neem tree in the neighbourhood improves health and it is very widely used even today as a tooth-cleanser. It is also woven in Indian mythology which explains its presence in the backyards of rural homes. Plants occupied an important place in India from Vedic times. For instance in Ayurvedic books of Charaka, Susruta and Vagbhata 1900 plant names, some of these synonyms, of about 750 plants are mentioned. The *Niganthus* text contains synonyms of some 500 to 700 plants or an average of 30 synonyms for each plant. Many of these texts such as *Amarakeshe* date back to 6th century AD. *Vrshayuveda* of Surapala manuscript is largely devoted to horticulture and botany. This also, covers preparation of manures and details of where and when to apply. This treatise of 13th century AD also covers plant diseases. *Upavane Vinode* is yet another work which deals with soils, seeds, watering, plant nutrition, pest and disease management and some botanical marvels.[8,9] *Krishi Sukhti* is yet another work on agriculture dating back to the 8-9th century AD. Several other books including those on *Materia Medica* also existed. [10]

Several seed treatments have been collected or collated some of which included use of bark of moluca bean. Many of

these treatments were based on use of milk alone and use of milk and cow dung mixture with urine. There were also many other specific seed related treatments for control of particular insect pests. For instance seeds of red gourd, egg- plant and snake gourd were recommended to be soaked in water. Rice seeds were given an elaborate treatment which includes overnight soaking in water, use of castor leaves and dung. Several methods for seed preservation were also in use such as soaking seeds in water. Use of *Viranga* with sesame oil was also recommended. For protection from parasites as also storage of paddy and jowar grains, use of *Ipoema fistulosa* was recommended. In another treatment, seeds were first soaked in milk for 5 weeks before exposure to *viranga* (*vidanga*) for fumigation using ghee. While *arsenicals* were being used moderately as insecticides by the 16th century, soon thereafter use of nicotine came in the form of tobacco decoctions.

By the 19th century, both pyrethrum from chrysanthemum and rotenone from the roots of the derris and soap were being used as also combinations of tobacco, sulfur and lime to counteract insects and fungi. Nineteenth century saw the trend towards systematic scientific approach of use of chemicals for plant pest control. This led to the use in 1867 of Paris Green in crude form of copper arsenate. This was specially used in the USA to counteract the spread of Colorado beetle. In fact this also led to the introduction of probably the first pesticide related legislation in the world.

Iron sulphate was also being used as a herbicidal agent and lead arsenate as a broad spectrum insecticide. Compounds of arsenic and cyanide and various coal tar derivatives also made their entry for insect control. Use was also being made of whale oil. While these products such as pyrethrum were generally considered safe, but many others specially nicotine and cyanide were highly toxic-specially for the sprayers and farm workers. Widespread use of lead and calcium arsenate on cotton in USA also exposed people to considerable risk. In the late 19th century the Bordeaux mixture—lime plus copper sulphate—was discovered and widely used to control various diseases of fruit trees. A French grape grower made a chance discovery of its anti-weed property. This later led to use of iron sulphate as a weed killer for cereals. This spurred further investigations and several other substances emerged. Another landmark was discovery of organo-mercury seed dressings in Germany in 1913.

This era may be referred to as first generation pesticides. As is now well-known, the insecticidal potential of DDT (dichlorodiphenyl trichloroethane) was discovered in Switzerland in 1934 by Paul Hermann Mueller while working with Ciba-Geigy. In 1939 Swiss farmers had successfully used this to combat Colorado potato beetle. In 1942 the Swiss Army used DDT to dust down the refugees to avert a possible typhus outbreak from lice. This was followed by commercial production in 1943 and use in Naples, Italy, to prevent a typhus epidemic involving some 1.3 million people. Mueller was awarded the Nobel Prize in 1948. World War II helped use of DDT as the US Army wanted to protect the troops from insect-vectored diseases such as malaria, typhus and sleeping sickness in the tropics. After the war, DDT was used both for public health and agricultural pest control.[2, 11]

This then was the second generation pesticide era involving use of highly toxic chemicals. In the process as we will see later the traditional methods, technology and wisdom were all but forgotten until its revival since last 2 decades or so largely because of the serious problems posed by these highly toxic and dangerous chemicals affecting adversely life on earth on many fronts. World War II also saw development of parathion and other powerful nerve gases as possible chemical weapons. The powerful herbicide 2,4,5-T later became infamous as the main ingredient of Agent Orange, used to defoliate vast areas of South Vietnam.[12]

By and large references in the vedic literature point towards a clear knowledge amongst farmers of principles of fertility of soil including understanding of different types of soil and their suitability or otherwise for the crops. In addition there was distinct knowledge of selection of seeds and their treatment, suitable time and season of sowing including atmospheric temperature, harvesting, rotation, manuring as also provision and need for water. Cow dung was widely used for manure and double cropping was in vogue. The system and practices developed and used were based on conservation and sustaining the earth and environment and effective utilisation of inputs. This was specially aimed at providing nutrients for the crops and keeping these healthy and strong to ward off pests and weeds. Obviously these came through long periods of keen observations. The hedges, the trees/bushes and even nearby "waste lands" for grazing provided sanctuary for insects, birds and other predatory and parasitic weapons for the pests.

Agriculture was closely tied to livestock for its obvious interrelationship and dependence for draught, manure and food.[13]

That the high degree of knowledge including intercropping was based on traditional experience and possibly wisdom has been documented by western scientists like J.A. Voelcker (1983), Albert Howard and C.C Wilson and later by F. Keating. For instance apart from use of animal dung as manure, nutrients were recycled by burning weeds and stubble in the fields. Value of crop rotation for various soils was well understood in Khandesh as is clear when we see that in black soils, finger millets preceded sesame. Whereas in light soils, finger millets followed pearl millet and then cotton.[14]

For dry crop land which permitted cultivation of only one crop a year a different crop pattern was used for 3 years. For irrigated lands likewise no other cropping pattern was employed. Legumes were included in these rotations. Since same crops were not grown continuously in the same field, this ensured soil fertility as also prevented build up of pests. Another common practice of sowing mixtures of seeds was commonly followed at the same time and in the same furrow. Some 8 different cereals were cultivated including several varieties of each, depending on end use and soil conditions.

At least 9 varieties of leguminous pulses/plants were cultivated including chickpea which also checked growth of weeds. Indigo a nitrogen-fixing plant, was also being grown. Chickpea fields were often edged with safflower as this repelled cattle and deer. White ants in sugarcane fields were kept under control by placing bags of powdered cowdung mixed with salt and copper sulphate in the main water channels as these were fungicidal.[15]

Unlike the present day mono-culture era, the traditional farmers relied on a wide range of trees, herbs, shrubs and climbers of a wide range of diversity. This resulted in not only improved productivity, year-round produce as also a degree of self-sufficiency in respect of food, feeds, fodder, fuel, fibres, manure, medicines. Brinjal was a popular vegetable and to control soil pests which attacked its roots, a mixture of buffalo dung and *asafetida* (*hing*) was smeared on the roots at the time of transplantation. To control grubs in the growing plant, a large bag of *asafetida*, garlic, camphor and sulfur was placed in the water channel. Cows urine was used to control leaf insects. Around

beds of *pan* (betel) for instance were planted common shrub *sesban* (shevri), white agaste (swamp pea, hadga) and pangara, the Indian coral tree. Incidentally it was no accident that these were all nitrogen-fixing legumes. Neem trees were planted in abundance. African marigold (genda, gul jofan) was also encouraged obviously for its insect repellent properties. Use was made by the Gondal tribals to line baskets with leaves of *Kojam* which is anti-fungal for preserving dried *Mahua* flowers for two years. These are known to be rich in carbohydrates and sugar. Thus in Khandesh, one region of Maharashtra alone, which provided not only matching type of food and nutrition but also served as a mini-food security system against crop failures, reliance was placed on some 80 types of crops. The plant diversity also helped to sustain a wide range of insects, birds which also resulted in supporting fish life in the streams. In many of the areas in Khandesh and elsewhere which have not been reached by 'modern ' science, many of these systems continue to this day.[16, 17]

Some crops were also used as live-repellents to cattle and wild animals. For instance *sann* was planted around cotton fields to keep away cattle and antelopes. Likewise *safflower* and *niger* were used in the same way since these were not relished by the trespassing animals in general. A wide range of shrubs and trees were grown as hedges which supplied food, manure, pesticides, medicines and even cash crops. Herbs and grasses also thrived apart from serving to keep out stray cattle as also in controlling soil erosion. Uses were found for weeds thereby eliminating the need for any weedicides. For instance *ak* (a milkweed) widely used as a green manure was also pesticidal apart from other medicinal values. It was also a common practice to plant Nitrogen-fixing trees such as *babul* right in the middle of fields. In South India a mahua tree was grown, though not leguminous but it attracted birds whose droppings provided nitrogen. As indicated earlier, *Vrkshayurveda* has detailed instructions on collection of seeds, their preservation and treatment before these are used. For instance seeds were fumigated with *virange* after smearing with ghee. Germination of rice in the nurseries was hastened through shading with young branches of *adulsa* and *buna* or by use of tender leaves of adulsa. This apart, plants like *ak*, *bandari*, *gulabas* and basil (*tulsi*) all of which are known for their insecticidal or fungicidal value were also employed during the germination process of rice. Winin Pereira has described in some

detail ingenious technology developed for destroying weed seeds and some soil pathogens in rice nurseries. Likewise fish in paddy fields was introduced and relied upon to control insect pests. Weeds were controlled through pressing down the young plants with a roller consisting of a broad wooden bar followed on the underside. Farmers also grew a purple coloured variety once in a few years to enable destruction of weeds that resemble rice plants; adulsa also killed weeds. It is thus clear from the foregoing that a good deal of the indigenous knowledge and the technology developed therefrom over the past thousands of years of agriculture has not been nurtured or used fully with the advent of the ushering in of western science which came through the compulsions largely of the foreign rule.

It is, however, fortunate as we will see in the following relevant chapters on Alternatives that a fair amount of the old experience continues to be used in the country possibly on account of general poverty of the farmers specially in the hills and dryland areas coupled with small land areas possessed by them. This may have also been helped by the fact that the heavy inputs needed under the Green Revolution technology were not affordable for them coupled with the innate inborn confidence in the traditional farming systems inherited through generation after generation. We will also see that the present day ideas, now being promoted under the Sustainable or Alternative Agriculture banners which is a response to our having burnt our fingers with agrochemicals and other heavy inputs, including energy, were in fact in vogue with the yester-years' farmer. Reference will also be made later to several indigenous examples from India and elsewhere on use of bio-fertilisers, leguminous plants, plant nutrients, weed and pest control specially use of plant pesticides, biological control apart from multi-cropping, catch crops, intercropping, crop rotations as well as principles of soil and water conservation.

Advent of Chemical Pesticides in India

Pesticide use started before 1947 particularly for control of malarial mosquitoes. The pesticides used in the country, prior to establishment of a Benzene Hexachloride (BHC) unit in 1952 by private sector Imperial Chemical Industries (ICI) near Calcutta, were entirely imported. This was followed by setting up of a DDT factory in Delhi by the Government of India's public sector Unit in 1954 under an agreement with UNICEF and WHO.

Large tea and coffee plantations owned largely at the time by foreign companies it appears had started using chemicals at the end of World War II whereas use of pesticides for field crops started sometime in 1948. In early sixties with the advent of high yielding varieties the use of pesticides increased and by 1960-62 manufacture of some 9 chemical pesticides had already begun. At the end of 1975 this figure had gone up to 41. Some 17 new pesticides were added to this list by the beginning of 1977. At the same time production of two fungicides and one weedicide were dropped by the pesticide industry. At present some 53 pesticides are manufactured in the country whereas 133 are registered for use.

The annual production of pesticides in the country is around 90,000 MT with a value of around Rs. 600 (1980) crores as against estimated world pesticide market of some US$ 26.8 billion (1990). Saventy-three per cent of the world market is controlled by 10 Multinational Corporations (MNC) whereas 20 MNCs control some 93 per cent.[18] There are some 80 technical grade manufacturers in the country. India's annual growth rate in pesticide manufacture has been estimated to be around 12 per cent. As is well known the MNCs in pesticide business are also leaders in fertilizers and seeds business. India's share in the pesticide market was almost 2 per cent (1988). It is generally believed that World War II provided a very strong scope for the chemical pesticide industry to grow. While this may be true, but in USA even in early twenties, annual sales of common commercial insecticides was around US$ 20 million.[19] For example in 1917 calcium arsenate was found to be very effective against boll weevil, a formidable cotton pest. In fact World War I stimulated development of synthetic organic pesticides in place of naturally occurring organic or inorganic products. The coal tar intermediates from petrochemicals also were used largely in the dye industry, medicines as also explosives. In USA, paradichlorobenzene (PDB) was also developed and successfully used to control peach tree borer as also clothes moth. PDB was in fact a by-product in the manufacture of picric acid used in explosives. The dramatic result obtained with use of DDT in public health earned it a "wonder" chemical reputation, similar to the discovery of penicillin. It's use was extended to agriculture to increase crop yields specially for potato production in New York state by 56 per cent and 68 per cent in respect of Wisconsin. The phenomenal success with DDT

encouraged intensive R&D work. About this time, synthetic insecticides started replacing other time-tested control methods such as rotation of crops. Another alternative suggested was use of BHC and DDT. It was generally accepted that the new generation of synthetic insecticides will not only control but eradicate pests.[20]

It is on record that between 1951 and 1976 farmer's expenditure on purchase of insecticides rose 1000 per cent from US$ 194 million to US$ 1.94 billion in USA. Between 1940 and 1975 insecticide use in USA jumped 10 fold. According to FAO, imports of pesticides by the Third World countries, from 1974-78, grew from US$ 641 million to nearly US$ 1 billion. In Africa consumption increased five-fold from 1964 to 1974 whereas in Philippines there was a five-fold increase from 1972-1978. Recent report on trade worldwide places the end user sales at US$ 30,265 millions in 1995 representing a 5 per cent market growth.[21] Tragically, world pesticide market in 1996 had reached some US$ 31.25 billions.[22] This seems to have slowed down to US$28.5 billion possibly due to higher value of US$.[23]

In India the production in 1966 was 13,948 tons which increased to 35,812 tons in 1976 and 54,919 in 1986 and 63,800 tons in 1991, which is about half the countries' installed capacity of 2.5 lakh tons for 1993-94. The estimated production of technical pesticides during 93-94 is over 75,000 tons as against production of 72,500 tons during 1992-93. In order to utilise the idle capacity in 91-92 manufacture was increased during 1992-93, obviously in order to boost exports.[24] The actual pesticide production programme, regulatory measures in India and some other countries will be considered in the following chapters as also the important official review programme of the pesticides in use which followed the widespread adverse reports.

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Chapter 2
Introduction of Regulatory Measures

We have seen that soon after the introduction of chemical pesticides in Europe where these were developed and successfully used for public health control, these came to India possibly through the British planters after the World War II. It seems clear that in the circumstances of total lack of control on imports of chemicals, or pharmaceuticals -- hazardous or otherwise, their use started without any fuss or debate. Even if some poisoning or deaths occurred these would have been effectively covered up in the far flung plantations run by the large and powerful British planters, some of whom ran their own dispensaries with medical practitioners. Further in the nature of things, the workers were hired and fired without any hindrance or payment of compensation, since most of them were daily rated workers or paid on the basis of their pickings for the day, hardly any reports could be expected on any cases of poisoning or any other ailments or distress.

In India, generally speaking the laws followed the British example and pattern. For instance it was only in 1986 that the Food and Environment Protection Act, 1985 (FEPA) was enacted. According to Peter Beaumont (1993), prior to FEPA, UK was one of the few European countries which did not have any statutory procedure for registration and use of pesticides. What was in operation in UK was the Pesticides Safety Precautions Scheme (PSPS) which was a kind of a voluntary mutual agreement between, manufacturers, suppliers and the administered by an Advisory Committee on Pesticides consisting of independent scientists. This unofficial committee had no legal authority although the PSPS was administered by it.[1]

The entire PSPS worked on the basis of voluntary, self-imposition of norms and it avoided the imposition of legal control, including non- imposition of standards such as stand-

ards on pesticides. Adherence by industry to pre-marketed product, registration procedures and usage by farmers and other users to use of pesticides also fell in this line. For instance PSPS also avoided imposition of legal control on pesticides in foods.

The Agriculture Poisonous Substances Act 1952 was limited only to regulation that protected agriculturists in the field during spraying operations. The event that led to the passing of the Insecticide Act, 1968 was the tragedy of food poisoning which took place in Kerala in 1958. Some 828 cases of severe poisoning and over 102 deaths were reported on account of the accidental entry of folidol (Parathion) into food grains and their consumption in Kerala and Madras States after being unloaded from the ship S.S. Jai Hind on a Bombay-Cochin shipment.[2]

During April-May 1958 there were reports of deaths in the erstwhile States of Kerala and Madras. The deaths and poisoning had been reported from an Army Camp – the Lok Sahayak Sena Camp, at Sasthan Kotta, Quilon District in Kerala State where almost the entire Company of 175 members became ill on 29 April 1958. Some 41 trainees, 2 army men and 3 other connected persons and 19 children from adjoining villages died. A court of inquiry was set up by the Ministry of Defence to investigate the happenings at the Camp under the Central Government.

In view of the widespread distress caused, the State Govt. of Kerala also set up a Committee of four to investigate the causes of poisoning. However, later the Govt. of India on 23.5.58 also set up a Commission of Inquiry headed by Justice J. C. Shah of Bombay High Court and 2 others. The Reports of the above two inquiry Committees were made available to the Inquiry Commission.

The Inquiry revealed that the *S.S. Jai Hind* carried a large quantity of cargo (some 2,179 tons) consisting of wheat flour, maida, rava, sugar, soap, oil, tobacco and other items, in addition to 55 cases of a liquid insecticide manufactured by Bayer's of Germany under the trade name of folidol E-605. Somehow the folidol cargo, although on each of the 55 crates, the word "POISON' was clearly and prominently marked, was handled as if it was a harmless chemical. This perhaps happened as the challan documents had described the cargo as such, obviously to escape payment of a higher tariff prescribed for

such goods.

On inquiry it emerged that some of the liquid crates containing folidol were damaged and had leaked on to bags of grain flour. It appears that at least 15 crates were leaking as their delivery was refused by the consignees at Cochin. The Inquiry Commission concluded that the sugar, flour, biscuits and rusks were contaminated with folidol and thereafter used in food, tea, sweets etc. This led to the deaths of more than 100 persons and illness of over 400 persons. The Commission pinpointed not only six important causes of the tragedy but also gave five solid reasons on how the contamination could have been overcome. The Commission reached fifteen main conclusions and general recommendations.

It was clear that the Shah Commission did its homework rather painstakingly and brought out full details of the 108 deaths and 1,031 other persons who were poisoned ranging from ages 2 months to 60 years in Kerala alone. In the State of Madras also some 33 cases of food poisoning and one death were reported. Victims were taken ill or died after consuming bread or bun from the bakers, biscuits, rusks, contaminated sugar used in tea, rava, uppumma, coffee, milk and sago sweetened with milk. Likewise consumption of a favourite family dish, *semiya payasam* made from maida flour with other ingredients also claimed several victims. Likewise *poories* served to carry folidol in several cases. Tragically these *poories* were rejected and thrown away, being bitter, by the inhabitants of the Lok Sahayak Seva Camp but poverty attracted children of the area to pick up these rejected *poories* to face death.

In some cases partaking of fried banana fritters and mokadam preparations which involve use of wheat flour, in this case contaminated, led to poisoning and deaths. In one incident contaminated sugar used for making sweet lozenges also led to poisoning.

A monograph on folidol was prepared for the Commission. This highlights the hard labour and seriousness with which such matters were handled in the past. The meticulously in-depth Shah Commission Report of 116 pages inclusive of detailed annexures clearly made out a formidable case to handle the situation which resulted in 110 recorded deaths and caused havoc to the health of over 1,000 recorded cases.

One would have thought that considering India had become independent with it's own elected and Parliament, that there would have been an immediate follow up action as the Shah Commission had made clear recommendations on the basis of it's incontrovertible findings. This was particularly necessary and urgent since the events in UK and USA, both English speaking countries with which we have had extensive contacts and exchange of information, had clearly established the dangers of pesticides to human , aquatic and wild life.

In fact in UK itself problems of safety of agriculture workers and pesticide residue in food and risks to wildlife had been gone into in depth by three different committees in 1951, 1953 and 1955 respectively. In the USA, a House Select Committee under the Chairmanship of Congressman Delaney was set up to look into problems of chemicals in foods, including pesticides. The Committee brought out three volumes of Reports in 1951 and 1952. This also led to the introduction of the famous Delaney Clause in the subsequent legislation, which had helped to prevent the introduction of any new pesticides which were in any way considered carcinogenic. In fact this Clause bars United States Environment Protection Agency (US-EPA) from granting permission to the use of any pesticide that was found to induce cancer in animals. So far-reaching and strong were the implications of the Delaney Clause that it frustrated efforts of manufacturers as also the US authorities to register new and powerful pesticides for use. In fact it is only recently that the US President Bill Clinton has under heavy pressure considered scrapping of the Delaney Clause after introducing sufficient protective clauses in the new legislation in order to safeguard public health.[3]

In 1964 a general study of the use of pesticides had been made and reported on by an Advisory Committee to the US President and a sub-committee which reported on the effects, uses and control of agricultural pesticides as also on research in progress. At about this time FAO and WHO had also started looking into the pesticide problem.

The Shah Commission report had indicated faulty storage, failure in packaging, labelling and worst of all a deliberate false description of the consignment in the Way Bills and Invoices as "harmless". This hastened the preparation of a Bill legally to enforce registration of all pest control items, and precautions

during storage. The Bill was to cover manufacture, formulation, transport, storage, sale and distribution. India's fourth Five-year Plan had envisaged a very large increase in the use of plant-protection chemicals. It was therefore agreed that in the light of the above and the views of ICAR, Ministry of Agriculture and Department of Food, that a review be made to determine measures needed for the future.

A Committee was thus appointed on 26.6.1964 by the President under the Chairmanship of Prof. M.S. Thacker, the then member, Planning Commission, assisted by one Secretary and one Technical Secretary in addition to 16 members.[4]

Terms of reference of the Committee were:

a. Whether the use of a particular pesticide should be prohibited entirely or allowed for some special purposes and under prescribed conditions;

b. What should be the future programme for the manufacture and import of pesticides in the light of the recommendations under (a) above?;

c. What other steps, such as the intensification of research on biological control, should be taken to reduce damage caused by insects and pests in the event of it being necessary to restrict the use of some pesticides? ; and

d. Any other relevant matter.

The Committee received some information on pesticide poisoning and on the pest and plant protection practices. The Committee received a mass of information from both official and non-official sources and R&D Institutions. Some of its members also had field visits. Discussions were also held with farmers and the Pesticide Associations.

The Committee did not make recommendations in respect of any particular pesticide which it thought should be under constant review by a technical Committee which may be designated/appointed for the purpose.

The Thacker Committee's Summary of Recommendations, which is by no means complete or all inclusive, covered organisation and regulations, specific hazards in current practice, role of education, alternative biological and other methods of control, manufacture and import matters apart from

general observations. The 17 member Thacker Committee appointed on June 2, 1964, submitted its Report in 1967 and it was in 1968 that the Insecticide Act was passed. However, it was only from October 31, 1971 that the Act was made operational and enforceable.

The test of any Act lies in the availability of quality foods, fibres and not to forget, water and soil as the pesticides seem to react with the entire Earth System. In addition the Acts are intended to protect the public health both from short-term immediate effects as also from any long term, cumulative delayed harm both to the persons involved and their progeny. An attempt will be made to touch on the various laws on the Statute before and after the Insecticide Act 1968 was enforced in 1971 and how these are serving the objectives the framers would have had in mind. We will also have a look at similar legislations in some other countries specially in the Western World where matters of public interest are generally taken far more seriously than is the case in the Third World countries.

The following legislations have been promulgated over the years in India which have a bearing on control of regulating pesticides which serve as poisons[5] :

Poisons Act 1919

Indian Drugs & Cosmetics Act, 1940

Indian Factories Act, 1948

Prevention of Food Adulteration Act, 1955

Insecticides Act , 1968

Water (Prevention and Control of Pollution) Act 1974

The Air (Prevention and Control of Pollution) Act, 1981

Narcotic Drugs and Psychotropic Substances Act, 1985

Environment Protection Act, 1986

Indian Penal Code - Forest laws- Consumer Protection Act

Prior to the enactment of the Insecticides Act, the Poisons Act 1919 and the Rules framed by the States thereunder, covered 9 toxic pesticides while 4 pesticides used in public health were covered under the Indian Drugs and Cosmetics Act 1940. However, the Thacker Committee Report, 1967 lists a total of 36 pest control substances under the State Poison Rules.

Poisons are generally defined as substances, when administered by any means, produce ill health, disease or death. The poison may be of synthetic, mineral, animal or of vegetable origin. However, in the event of criminal poisoning cases, the law in India does not insist on the limited definition of poisoning. The Act passed in 1919 has been amended from time to time and extended to the whole of India. The Act empowers the Government for the importation and sale of any particular poison(s) and also grant of import licenses.[6]

Drugs and Cosmetics Act 1940 is another legislation to regulate imports, manufacture, distribution and sale of drugs and cosmetics. A Drugs Technical Advisory Board, the Central Drugs Laboratory and the Drugs Consultative Committee are an integral part of this legislation. The import of drugs and cosmetics including standards of quality, misbranded drugs, adulterated and spurious drugs as well as cosmetics fall within the purview of this Act. Likewise coverage of manufacture, sale and distribution are a part of this Legislation. As amended in 1955, the Act also covers insecticides, disinfectants and contraceptives.[7]

The Indian Factories Act basically covers the labourer in the factories—specially those affected from poisoning due either to lack of knowledge or on account of negligence on the part of the owner or the worker. This covers industries involving hazardous products and processes as listed in this legislation. Under the Act any hazardous process is to be scrutinised by the Site Appraisal Committee. The Factory authorities are required to disclose full information on dangers including any health hazards involved and the measures provided to check-mate any mishaps and dangers to the workers and the general public.

In addition the Act prescribes maximum permissible threshold limits and levels of exposure for chemicals and toxic substances while handling and working with hazardous chemicals for the workers. Stringent punishment has also been provided (prison term of 7 years and a fine up to Rs. 2 lakhs which is approx. US $ 6,000) for contravention of the provisions of the Act.

Although the Factories Act and the Rules lay down in detail the safety regulations, including the duties and responsibilities of the Inspectors, as also the attending medical practitioners etc., in practice the situation is far from

satisfactory. For instance the workers generally are not aware of the hazardous nature of the chemicals they are exposed to.

Prevention of Food Adulteration Act lays down the tolerance limits of pesticides in foods amongst many other items. So far, out of the 133 registered pesticides, limits have been laid for 50 only. To add to this situation, strangely enough instead of prescribing the maximum residue limits for each of the pesticide depending upon its known toxicity data, irrespective of which foods these are found in, limits have been laid down only in case of certain categories on the assumption that the users will stick to the recommended use only. The Act also does not cover pesticide contamination of water, animal feeds, air or soil, which more often than not can be serious sources of contamination and the resulting danger to health and environment. The Insecticide Act was passed in 1968 but as indicated before, this was enacted only from 1.8.1971 after the Thacker Committee, appointed in 1964, submitted its Report in 1967. To recall, the Thacker Committee was appointed following the Shah Commission Report in 1958 following which an Insecticide Bill was introduced in the Indian Parliament in 1964.

Broadly speaking the Insecticide Act despite all its weaknesses and lacunae is quite a comprehensive legislation and if enacted seriously could sub-serve the purpose which led to its enactment in order to protect public health and interest. The Act has attempted to cover various regulatory provisions in respect of imports, manufacture, transport, distribution and use in order to prevent and forestall risks to human life. Under this Act two statutory bodies viz., the Central Insecticides Board and the Registration Committee have been constituted. The Board is headed by the Director General of Health Services with some 28 other members concerned with various interests and segments. The Board has been assigned a wide range of duties and responsibilities, the thrust of which is to offset risks to life in general and protection of the environment. The Registration Committee has also been assigned a wide range of broad based responsibilities including registration of pesticides after due and rigorous scrutiny. This includes verification of claims by the importers and manufacturers with special reference to efficacy and safety. The Committee was also charged with the task of laying down precautions needed against poisoning through the use and handling of pesticides and to carry out other related tasks.

A rather detailed registration procedure has also been laid down under four stages. The first of these spelled out procedures for imports of sample quantities of pesticides, not registered in the country. The second stage covers procedures for inclusion of pesticides in the Schedule to the Act for the purpose of imports or manufacture.

The third stage concerned steps and procedures for provisional registration for purpose of imports and manufacture while the fourth stage covers procedures for regular cases of registration of the pesticides under the Act. The legislation also provides for a licensing procedure which *inter alia* covers cancellation of the license if the application for registration is rejected or refused by the Registration authority under any provisions of the Act. The license can also be issued unconditionally or subject to any conditions. The decisions of the Licensing Committee are however subject to a judicial review.

The Insecticide Act is to be enforced through the Licensing authorities in each State through their own inspecting staff, who are also required and authorised to draw samples for analysis. A summary of pesticide regulatory practices and enforceable measures as prepared by the Indian Institute of Management, Ahmedabad, highlights the rather complex, industry-oriented set up that has been created which seems to offer no protection and support for the consumer.[8]

While the Act as in force appears to have been well-formulated, nevertheless experience over the years has drawn attention to many shortfalls and lacunae in its operation. First of all there is the dichotomy that while the Act is formulated by the Central Government, its' implementation is almost entirely in the hands of the systems of operation enforcement and priorities at the State level.

For instance until very recently several of the States, contrary to the clear requirements and provisions of the Act, had not provided for issue of a notification making reporting of poisoning /death from pesticides compulsory. This has resulted in non-reporting of poisoning cases leading to a feeling of false security. This has also hindered R&D efforts towards finding alternatives to highly toxic pesticides.

There is also a noticeable wide range of variations of the understanding, interpretation and implementation of the provisions of the Act particularly for preventing intentional or

accidental consumption or exposure and contamination.

There is a similar lackadaisical approach in taking speedy preventive measures to control entry of the pesticides in use which enter air, water, soil, food, farm products including animal feeds. There is thus a widespread feeling that while the law prescribes Dos and Don'ts as also upper safety limits and upper limits for pesticide residues in foods, this has been done in a manner where the culprits even if hauled up, would go scot free. In fact there is no evidence of any challan of any offender since the Act came into force in 1971. It is clear that there is absence of monitoring, overseeing and coordination amongst the various functionaries charged with this responsibility. The lacunae are also clear when we see that in the developed countries on account of vigilance and strong consumer groups there is often swift corrective action. In India on the other hand steps taken to review even the pesticides banned in other countries of origin are rather slow to put it mildly. In fact some of these banned pesticides are under manufacture by the public sector units of the Central Govt. itself over some of which it has a monopoly.

Apart from this totally unsatisfactory position in respect of pesticide residues there is hardly any monitoring or corrective action in respect of even the pesticide contamination of everyday foods. As we will see later, there is also no restrictions on advertisements through the media nor is there any effort to create awareness amongst the ignorant public -- be they farm workers, farmers or housewives, factory workers or the consumers at large specially the children and women who often are the mute sufferers.

As we will see, the plethora of legislations which were intended to control pesticide use and dangers, sometimes creates a lack of clarity amongst the legislation implementing agencies themselves.

A significant legislation enacted in 1974 was the Water (Prevention and Control of Pollution) Act. This was aimed at providing for the prevention and control of water pollution and maintenance or restoration of wholesomeness of water. The Act also provided for setting up of Boards for the prevention and control of water pollution in the States and for arming these Boards with suitable powers and functions.

The Act, as generally is the fashion in Indian legislations,

lays down heavy penalties and tedious procedures. For instance for wrongful use of streams or wells for waste pollutants there are heavy penalties. Likewise there are penalties galore for discharge into the water supply sources or for entry of sewerage or trade effluents.

There are also provisions for giving publicity for provisions of the legislation for the unwary offenders, which includes the Government Departments themselves. However, the procedures for taking cognizance of offences has been couched in mysterious terms which makes it difficult if not impossible for any public interest bodies, except with the permission of the State Boards, to move in these situations. To make it worse such cases can be heard only by specially designated Metropolitan Magistrates or Judicial Magistrates of the First class level (whatever that may mean).

There are other built-in problems. For example there is near non-existence of Water Testing Laboratories for samples drawn by official agencies and almost total non-existence of laboratories for water testing by the affected citizens or any of the public interest groups or organisations.

There is also on the legal anvil, the Air (Prevention and Control of Pollution) Act passed in 1981. This deals with the control of objectionable emissions from various industrial processes, including automobiles as also noise pollution. The Act provides for a criminal complaint under Indian Penal Code for causing common injury, danger or annoyance to the public. However, the shoddy and weakly worded legislation, in practice, is unhelpful in providing any worthwhile remedy. To make it worse the Act is applicable only to areas declared as Air Pollution Control Areas (APCA) by the States. There is a further catch in this, as only the Industries enlisted in the Act or covered for any default can be taken to task. There have been many instances where the companies not listed, even through an oversight or otherwise go Scot free.

The Narcotic Drugs and Psychotropic Substances Act 1985 repeals the Opium Act 1978 and the Dangerous Drug Act 1930 and covers poisoning due to consumption of some 77 substances.

The Environment (Protection) Act 1936 provides for protection and improvement of Environment and follows the recommendations of the UN Conference on the Human Envi-

ronment held at Stockholm in June 1972 to which India was a party. The Act aims at reduction in poisoning arising from use of hazardous chemicals. The Act provides for standards for quality of environment, for control of emissions and safeguards for handling of hazardous substances. It also provides for inspection of processes, factories for taking corrective and remedial steps. Under this Act the has been vested with wide powers to protect public health from chemicals, including pesticides. The Act also provides for constitution of an Authority for implementation of the Act. There is also provision for setting up of Environmental Laboratories under the Act to help implementation of any standards laid down under the Act.

Yet another landmark has been the Consumer Protection Act 1986 for providing better protection of consumer interests which also includes establishment of District Forums, Consumer Protection Councils both at the State and National levels. Many of these Forums, State Councils and the National Consumer Councils have been setup with pressure of public opinion from several effective Consumer Groups and these have made considerable progress towards protecting consumer interest, with special emphasis to enviro-health. A number of far reaching judgements have emanated from these Courts on several matters of pressing public concerns, which were earlier almost impossible to draw attention to.

An important development has been that these courts are authorised to take action either *suo moto* or on receipt of a complaint from any citizen without having to hire the services of legal persons and without having to go through the crippling and self-defeating court procedures which in the nature of things took a very long time to come to any decision. Unfortunately with the enormity of the tasks, the initial relief provided by these agencies is considerably on the wane and these Courts are also becoming same bottlenecks as has been the case with our other legal institutions with early justice no where in sight.

Consequent to the proliferation of the hazardous industries, particularly the chemicals industries and accidents like that of the Union Carbide at Bhopal and Shriram Oleum gas leak at Delhi in 1991, a law has been passed to provide for insurance and compensation in such accidents. This provides for compul-

sory Insurance and formation of an Environment Relief Fund. Sadly, this law provides exemption to the public sector units, which makes a mockery of this law considering that some of the largest chemical firms are in the public sector.

It is thus clear that starting from the Forest Laws which protected the forests, now part of the Environmental vocabulary, and the age old Section 278 of the Indian Penal Code, there is now a wide-variety of legislation available. Unfortunately with ill-defined and quite often ill-conceived and overlapping laws, despite good intentions, the necessary infrastructure has not been set into motion to effectively implement the intentions and lofty ideals into deeds. Thus by and large these laws are turning into paper tigers or have become defunct in the absence of strong public opinion and awareness. It is also to be noted that the responsibility for initiating action under these laws has been relegated to individuals and NGOs while the authorities of the State, especially the highly specialised Boards created, seldom if ever come forward to provide protection or help and assistance of any kind.[9] This is inspite of vast resources and information available with them and the responsibility to defend and protect public interest and the constitutional rights of citizens specially the right to safe & clean air and water covered by the Right to life under Article 21 of the Constitution of India. Incidentally the judgments of several High Courts including the Supreme Court of India have clearly supported the need for designated officials to come to the aid of the citizens.

Hopefully out of this jungle of laws, some day, a simplified–easy-to-grasp legislation with attendant infrastructure–may emerge which would be of great help for the country's mauled environment, ecology and enviro-health. This is unquestionably essential for the survival and well-being of the future generations.

Regulatory picture in some other countries

Having discussed the wide variety of legislations in force in India, an attempt will be made to see how similar problems are being attended to through comparable legislations and regulatory systems in some Western countries, many of which are miles ahead of us in meeting the challenges of the chemical age.[10] For this purpose reliance will be placed largely on the excellent, detailed United States General Accounting Office

(US-GAO) Report on Pesticides undertaken for the US Senate. Incidentally the US-GAO is the counterpart of the Comptroller and Auditor General of India.

Surprising as it may seem, in UK the first legislation, the Poisonous Substances Act, was introduced in 1952 following seven deaths from use of a herbicide. The Pesticides Safety Precautions Scheme (PSPS) was in force until 1985 when the Food and Environment Protection Act (FEPA), 1985 was passed. The PSPS was a voluntary arrangement between the, the manufacturers and suppliers, an agreement which is believed to have worked largely to the advantage of the manufacturers with exhibiting minimal interest in the matter. For instance, strict legal controls like food residue limits for pesticides had been avoided in UK. Obviously the intention was to ensure maximum agricultural production, under what now turns out to be a mistaken belief, that without the use of chemical pesticides, the food production would suffer.

The PSPS was administered by an Advisory Committee on Pesticides, consisting of independent scientists appointed by the UK although in effect it had no legal authority or standing. Although the PSPS provided a certain degree of control, including a list of approved pesticides–by and large it's discussions and various decisions were taken in secret, not easily available to the public and not transparent. In other words the information provided by the industry was under cover and not subject to any critical scrutiny even in matters and questions of public health and safety.

FEPA in UK provides powers to control sales, supply, use, distribution and marketing of pesticides. This was essentially an enabling legislation for which secondary legislation was used to establish various norms. In UK in 1986 the Control of Pesticides Regulation (COPR) was introduced which provides Guidelines. This was followed in 1986 by Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR).

These were intended to reduce, if not eliminate any under reporting of cases by employers by requiring an immediate oral and written report within seven days of its' occurrence. In 1988 the Pesticides Regulations (Maximum Residue Levels in Food) were framed. These set maximum levels for certain active ingredients and defined powers to seize and dispose of food contaminated in excess of the laid down limits.

Control of Substances Hazardous to Health (COSHH) Regulations were introduced in 1989 in order to encourage farmers and sprayers to make a full assessment of the risks they faced from the use of hazardous chemicals. The Regulations highlighted technical measures to reduce effect of exposure.[11]

Despite the fact that the UK has been exporting–with external sales in 1991 touching over £750 million (as against £ 415 millions sales within the country)–with serious attendant consequences, it surprisingly does not as yet have any set of regulations for control of exports. It is possibly for these reasons that there has been a widespread demand for the training of users and for communication of the dangers to the importing countries under the Prior Informed Consent (PIC) Clause. The UK, however, provides control through Codes of Practice which cover storage, use and supply.

In UK the Ministry of Agriculture, Fisheries and Food (MAFF) is the controlling and nodal authority for 5 other departments which are involved and share the responsibility for Employment, Environment & Health. There has been a feeling of concern on use of some 274 pesticides, many of which were registered and approved for use in the early years without any detailed screening. This matter has also figured in the British Parliamentary Committee Report 1987 , headed by Sir Richard Body which has called for urgent review. Consequent to this the MAFF in 1989 decided on a review of some 450 chemicals. The review programme was later cleared for 296 pesticides out of which 22 were voluntarily removed by the manufacturers leaving 274 to be reviewed. The slow rate at which these pesticides are being studied has given rise to fears of risks to health as also safety of the environment in the long intervening period.

In USA, on the other hand the first legislation for pesticides was introduced in 1910, covering manufacture, sale, transport, mislabelling or adulterated chemicals. A system of compulsory registration was introduced under the Federal Insecticide, Fungicide and Rodenticide Act 1947 (FIFRA), which was handled by the United States Department of Agriculture (USDA). In 1972 FIFRA was amended with far more detailed procedures. The new system of reviews involving 70 pesticides, taken up in 1975 led in 1987 to 5 pesticides being banned, and the imposition of some new restrictions in the case of 34 pesticides. It is however feared that at this rate,

the review of some 600 chemicals in use in USA, would not be completed until 2015 A.D![12]

As indicated earlier, the US-GAO as a top watchdog body was seriously concerned about the potential health and environmental effects of pesticide use, both at the national and the international levels, specially in the background of growing global agricultural trade. It was in this background that the US-GAO reviewed the pesticide regulatory systems of the USA and Organization of Economic Co-operation and Development (OECD) member nations.

This study was particularly to go into the types of experimental data needed for registering food-use pesticides, the organisational structures in existence, risk assessment and management procedures and enforcement of pesticides standards. One of the eventual objectives was the possibility of harmonisation of regulatory processes particularly in the background of the General Agreement on Tarrifs and Trade (GATT) agreement.

The study covers 18 OECD countries and the EEC, which found a great deal of agreement between the data requirements of these countries and the USA in respect of toxicology tests. However, the agreement was less pronounced in respect of measurement of impact of pesticides on environment and wild-life.

There were also noticeable differences in respect of test protocols used in OECD which were not well developed in several countries as compared to the US-EPA Guidelines, although the situation in EEC countries was much better. There were other differences as in the data evaluation methodology. For instance USA uses a quantitative risk assessment module for cancer risk estimation as against the threshold module used in OECD countries. Whereas OECD countries rely on data on product efficacy, in USA, reliance is placed on market forces to minimise the use of pesticides. Compared to USA, in OECD countries the procedures and criteria used for registration of pesticides tend to be not available for public scrutiny.

OECD countries generally focus on pesticide residues in imported foods and not so much on foods exported. Also where national standards do not exist, FAO-WHO standards are used by OECD, unlike the USA which does not follow such

a practice. There were many fundamental, basic differences between OECD countries' pesticide regulatory systems. Some of the tabulated information presented in the US-GAO Report would be extremely useful to the various agencies in this country for comparative purposes. For the same reasons tabulated data on the salient points of regulatory systems in some of the developing countries compiled by Conway and Pretty based on the data of the Asian Development Bank, Manila would be considerable value.[9] It is also abundantly clear from the examples cited above that there is a pressing need to streamline the various practices, laws and regulations and evolve a single regulatory standard as has been very effectively brought out in the US-GAO Report.[13] presented to the US Congress. This excellent Report brings out forcefully how different standards in two key federal laws the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the Federal Food Drug and Cosmetic Act (FFDCA) have led to differences in the manner pesticides used on foods are regulated. These differences have their origin in law rather than science and are now generally referred to as the "Delaney Dilemma" after introduction of the Delaney clause in the FFDCA.

As a result of this clause, pesticides that were found to cause cancer may be used only on some foods which in effect limited the use of pesticides for purpose of increased crop yields. In effect except for limited exceptions for animal feeds, a pesticide required clearance under Section 409 of FFDCA if the pesticide has been found to induce cancer in humans or animals. In general the above detailed study showed that there was a broad agreement on the acute and subchronic toxicity tests for assessing effects on human health. On the other hand there was less agreement in the area of environmental and wildlife tests requirements, highlighting differing national concerns and interests. There were also serious differences in methodology for data evaluation and procedures for Cancer Risk Assessment. Obviously the evaluation of risk assessment had cultural and political overtones. The enforcement measures for pesticides standards also varied widely across the OECD nations studied with emphasis on either local produce or primarily on food imports as in the case of Sweden and Germany.

The trends in the OECD also showed a move towards

harmonisation in the regulatory system, which had received added impetus after signing of the GATT agreement which may minimise trade difficulties while safeguarding health and environmental issues. On the other hand this harmonisation amongst developed countries may also lead to problems in the exports from the developing countries. A concrete example of this has been the recent tight curbs on exports of farm products – tea, coffee, cotton and jute products from India to Germany. The danger also lies in the misuse of such agreements by forcing lower sale prices of the exporting countries apart from use of this for political gain, as has been the case with the Food Aid.

An example of this possibility may be judged from the US-GAO Report which covers comparison of US and Mexican pesticide standards and enforcement issues.[14] The US is a major importer of agricultural products as can be seen from this report. In 1990 for instance of the 1,4591,582 MT of fruits imported in USA, Mexico accounted for 34.5 per cent. During the same period of the 1806,736 MT of vegetables imported by USA , 66.4 per cent was from Mexico.

Now that the USA has embarked on a North American Free Trade Agreement (NAFTA) to increase trade, the efforts may lead to a weakening of harmonisation of strict US standards on pesticides or a reduction in food safety standards. Hopefully these will not become a handle for lowering prices for Mexican exports or used as a political whip in the future. But for countries such as India which are intent upon exports of various farm, animal or marine products specially to the affluent west or middle-east countries, it would be wise to foresee the need for a strong regulatory system to ensure permissible pesticide content or better still to move towards the production of organic food products, learning from its' own experience as also from the situation in respect of Mexico as brought out in the above US-GAO report.

In the USA 98 different pesticides have so far been identified in the ground water of 40 States. Some of these like chlordane, heptacholor, alachlor, parathion and malathion have also been isolated from fog and rainwater—showing the serious nature of pesticide pollution. Pesticides such as diazinon and carbofuran used on the farms, lawns and golf courses have also been implicated in massive bird kills. Exposure to OC pesticides including dicofol have been linked with

crossed and shortened bills in birds. A noticeable reduction in the phallus size of alligators has also been recorded, which makes reproduction very difficult if not impossible.

As indicated, the Delaney Clause of the Food, Drug and Cosmetic Act (FDCA) in USA prohibits the addition of carcinogenic pesticides in processed foods, although the Clause was not enforced until recently. A paradoxical situation has arisen in the USA in respect of several unregistered pesticides manufactured in that country for export only. USA is now confronted with the very same pesticides which are now finding their way back to USA through the imported foods!

Thus the overwhelming public concern over the use of pesticides has resulted in three different private pesticides Bills in the US Congress. One of these widely supported is the Pesticides Food Safety Act introduced by Henry Waxmar. Although the Bill does not directly touch on the Delaney Clause, it provides for phase out of the most toxic pesticides in a period of five years. In April '94, the US announced a Bill which provided for a goal of 75 per cent of US Farmland adopting Integrated Pest Management (IPM). However, this Clause has since been dropped due to pressure from vested interests although this may halt the export of a few banned pesticides.

The public interest generated in India by a few Enviro-groups has however had some effect and had induced one MP, Mr. Suresh Pachauri (later a Minister in the Govt.), to introduce a private members'Bill (1994) further to amend the Insecticides Act 1968. The bill sought to provide for compulsory training to the user by the manufacturers, free provision of a safety First Aid Kit to each farmer and suitable compensation in cases of poisoning of farm hands and animals. More importantly the Bill sought to make it obligatory for the to promote the production of non-chemical indigenous insecticides and to do away with the manufacture of poisonous pesticide chemicals in the country. That the powerful lobbies will not permit passage of such a Bill and even if it passes, many time consuming hurdles and road blocks is a foregone conclusion. However, its very introduction shows that a measure of public awareness has been generated. It is thus clear that the regulatory system, with all its weaknesses appears to be most highly evolved, developed and operational in USA, whereas the position in OECD/EEC countries is not uniformly comparable.

On the other hand the situation in developing countries is far from satisfactory and calls for immediate remedial action in order to protect public health and other concerns. In passing, one may question whether the impressive setup in the USA is a mere accident or is the result of pressures developed by a well-informed public which largely works through highly alert, involved and motivated citizen groups which seems to exercise sufficient and timely pressure on the concerned policy and decision making authorities in Government.[15]

As we will see time and again the answer lies largely in the Non-organisation (NGO) consumer groups aligning themselves with helpful authorities where necessary and possibly to obtain factual information and hard facts on various points taking advantage of the right to information and good sense and conscience of the public servants themselves to bring these to wide public attention nationally and globally through relentless networking and campaigning.

Implementation of Insecticide Regulations

It is clear that a strong regulatory system has been created taking advantage of the Shah Commission and the Thacker Committee Reports, which has in its turn paved the way for the creation of a strong pesticide industry in the country. As we will see, in doing this many of the useful and essential safeguards envisioned by these Reports have been ignored leading to creation of a monolithic chemical-based industry largely based on the western system. This is despite the fact that there has already been serious distress and public opposition and concern in these technically advanced countries generating a serious review of the pros and cons of the chemical pesticides. As we will see later this also led to strengthening of the R&D efforts for finding viable and safer alternatives to the highly toxic chemical pesticides.[16,17,18]

As is known at present some 133 pesticides have been registered for use in the country in addition to the use of Neem, *Bacillus thuringenesis* and *Bacillus sphaericus* on a provisional basis and permitting their use and production on a commercial basis. Another 19 (including the above three) have been provisionally registered for import/manufacture for the purpose of data generation and/or large-scale trials though not for commercial production. The question does come to mind that if in actual practice whether such a provision can be imposed considering that the implementation of the provi-

sions of the Act is the responsibility of the States many of which just do not have the necessary infrastructure for the purpose.

The authorities have also notified a list of 18 pesticides which have not been approved for use. Twelve other pesticides have been placed on the Banned List as on 31.12.'92. Likewise restrictions have also been put on the use of 13 highly toxic pesticides.

In addition some 17 pesticides are under review by the.[19,20] Data on the production capacity of technical grade pesticides in the country as also the licensed capacity, the installed capacity and the production for the past 2-3 years shows somewhat upward increase in production in India. The production figures indicate the percentage share of different groups of pesticides—with insecticides leading with a high share of over 82 per cent, followed by herbicides with a share of 8.3 per cent.[19] Production capacity of some 60 technical grade pesticides with names and places of manufacture in the country will indicate how well-spread and well-entrenched this industry is with an annual production and sales aggregating some Rs 1000 crores.[16] Many of the sites have been located in the interior, rural areas, the so called backward areas inhabited by the tribals and other weaker sections of the society in order to take advantage of the s' liberal policies for setting up industries in such areas. In addition to these manufacturing units, there are a large number of formulating units spread all over the country which work in close association with the manufacturers of basic technical pesticides.

There has been a growing emphasis on the exports of pesticides, a development that has been actively supported by the United Nations Industrial Development Organisation (UNIDO) and other national and international agencies. To some extent the export trade has received stimulus from the trend in the affluent manufacturing countries towards closing down units which are generating a great deal of hazardous wastes apart from other environmental pollution and which are currently under serious scrutiny on account of strong public opinion which is being helped both by the official environmental agencies as also powerful public interest groups. The quantum of exports for three years shows the trends of value and quantities and the increased range. This also shows that

the export market is thriving and the importers range from the third world to the most affluent, some of which have been the pioneers in this area.[18] According to the list compiled by the of India there are some 34 pesticides which are in use in the country which have been banned or restricted in many other countries but are in use here. Some of these are under review for possible restrictions and or ban. The public sector in India has pioneered the entry and manufacture of the pesticides in the country and these occupy pride of place in the successive reports of the concerned Ministry of Chemicals. [13,16] Likewise the capacity and production of some 9 'important' technical pesticides during the two years and the details of the pesticides produced by the public sector for the same period as well as the projections for I994-95 have been brought out in the same Report. It may be mentioned here that some 125 units are currently engaged in the manufacture of pesticides (technical) grade and other 500 units are involved in formulations which has also resulted in decreased imports and increased exports. The estimated production during I994-95 was over 75,000 tons as against around 72,000 tons during 1992-93. During 1991-92 the country exported pesticides valued at Rs 213.4 crores which had improved to Rs.281.3 crores during 1992-93. A report shows that during 1996-97 Indian exports grew by 65% to US$ 238 millions while the Indian pesticide market grew by 7.5% to US $ 602 millions.[21] The country has embarked on the manufacture of newer pesticides for which intermediates are being imported at present due to lack of the right technology in the country. These newer pesticides include Butachlor and Endosulphan amongst others.

Based on earlier experience ,the concerned nodal Ministry of Agriculture have worked out the estimated demand of pesticides from the 32 States and Union Territories(UTs) for 1993-94 which works out to some 84,095 tons.[16,19] Considering the buoyancy in the exports of farm products including plantation crops like tea, coffee, cotton and rubber, there is likely to be further upward trend in production of pesticides in the coming years although the very recent trends of the ecological farm products and the Green movement which is now sweeping USA and Europe may turn the tide against the trend to higher production. It is clear thus that many of the pesticides which after prolonged use in the countries of their origin were either withdrawn, restricted or put under scrutiny or in some cases banned, continue to be in widespread use in

this country. India also continues to be extra active on the export front including the export to the third world countries and others knowing fully well the dangers involved in the light of poor nutritional status of those handling it either in manufacture or use in agriculture or public health operations or the consumers of pesticide containing foods and illiteracy coupled with poor training in these countries. Worse still one of the largest public sector pesticide units has been located in one of the thickest populated areas of the Capital city of Delhi with a population of over 10 million showing that the lesson of Bhopal has all been forgotten. This is also in spite of many official warnings issued to the Unit over the years including the threat of the new State Govertment of Delhi given publicly for ending the gross environmental pollution caused by the plant including untreated discharges in the water systems and supplies to the city. The Unit has been manufacturing DDT apart from butachlor, BHC, malathion, endosulphan, five more important pesticides in use in the country.

Recently the Hinduthan Insecticide Limited has also commissioned a plant for manufacture of Monocrotophos. This public sector unit is also establishing manufacturing facilities for phosphomidon and carboxin and is also planning to take up manufacture of dicofol and mancozeb. This public sector Undertaking is operating from five locations in the country with a very large prestigious R&D unit on the outskirts of the National Capital Region of Delhi in the township of Gurgaon. The Undertaking has been running under considerable losses since its formation and operations in 1954.[16] The Unit however prides itself on its export performance with an all time high of Rs 424 lakhs during the year 1992-93 to various countries including Austria, Argentina, Belgium, Germany and Mexico. During the year 1993-94 the public sector is anticipating exports amounting to Rs 608 lakhs.

Registered List of Pesticides- S.N. Banerjee Committee Reports

Unlike in the western world with powerful public interest lobbies and Groups, there has been very little organised pressure on the Government for review of the pesticide scene specially in respect of some of the highly poisonous and toxic pesticides under manufacture and in use in the country. However, over the years there have been several press reports some of which have figured in the Parliament which had also linked several cases

of poisonings to the use of pesticides on the farms. This is apart from use of the pesticides for committing suicides, which was made easy by the powerful toxic nature of several of these and their easy availability in the markets all over the country specially in the rural areas coupled with the rather low price. Further the purchase of these chemicals would not ordinarily raise any suspicion in the mind of the dealers.

In any case the purchase of such pesticides was also made easy since no prescription was needed for purchase. It was obviously in response to these occurrences that in mid-August 1984 the Ministry of Agriculture appointed a high-powered 22 member Expert Committee to review all the pesticides in use at present in the country with a view to ban the production, import and use of those that are no longer in use in other countries.[22] The Committee was also to recommend safer substitutes for pesticides which had been banned or phased out in the countries of their origin. The Committee was to report to the in two years time.

The Committee had its first meeting on 26.10.84 and then subsequent 3 meetings following the Union Carbide Factory Disaster at Bhopal which gave further urgency to the work of this Committee. However, the first report of the Committee on DDT came in July 1985 and the one for BHC in July 1986.

The term of the above Committee was first extended by a year upto August 1987 and once again by another year to August 1988. On 17 October 1986, the Chairman of the Committee appointed a sub-Committee to prepare a Draft Report on the Cyclodiene group of pesticides (Aldrin, dieldrin, chlordene and heptachlor). Three of the 5 experts co-opted by the Chairman were drawn not from the 22 members of the Committee appointed by the but were taken from outside. Atleast one of these members was an employee of Indian Explosives Ltd (IEL), which was engaged in the manufacture of half-a-dozen pesticides including BHC and paraquat. In any case the Committee submitted its report in July, 1987 alongwith a report on EDB for which a separate Committee had been appointed. In addition the Committee submitted its report on seven other pesticides, namely captafol chlorobenzilate, captan, DBCP, PCNB, sodium cyanide and toxaphene, a total of 14 pesticides before its term ended in August 1988.

After a lull (or was it rest), the Ministry of Agriculture on October23, 1989 reconstituted the above Committee under the same Chairman with a total of 22 members and with about the same terms of reference as the earlier Committee of 18 which was later enlarged to 22. Whereas the first Committee was authorised to study 'all the pesticides in use at present in the country' against which only 14 were reported on, the new Committee's work was somehow limited to 16 pesticides to which PMA was added later by a special notification on April 30, 1990. In the course of their work the Committee was required to work through 5 Task Forces whose Chairmen were also selected by the directly. The Committee had its first meeting on January 1,1990 with five subsequent sittings leading to submission of the Final Reports with a Compendium in April 1991 to the with a wide variety of evasive recommendations not in consonance with its clear terms of reference.

During this period the matter figured prominently both in the press and the Parliament largely on account of the pressure generated by some of the NGOs. Despite this pressure, there has been a rather delayed action on the various reports starting with DDT and BHC as can be judged from the Action-Taken Report of the Government given in the Parliament on August17, 1993.[23] In response to further questioning in the Parliament (Lok Sabha) a somewhat similar status report was presented on March 01, 1994 which also shows pesticides under review which are banned in other countries.[24] It was about this time that an NGO brought out a report entitled *Banned and Bannable Pesticides*[25] which was a further boost to the Pesticide Action Network's (PAN) powerful campaign, world wide, popularly called the Dirty Dozen although the list was later enlarged to cover 18 pesticides against the original dozen.[26] The colourful and the impressive *Global Dirty Dozen Chart* gave the status of each of these 18 pesticides countrywise.

It would seem from the above that all along pressures were at work to thwart the working of the two Committees which were working from 1984-1991. This is evident from the midcourse changes in the functioning of the Committee leading to its needless reconstitution and related delaying tactics including constitution of the Task Forces and obvious weightage given to the vested interests. As it is there has been

hardly any effective implementation of even the watered down decisions of the Government on the Committees recommendations even though these were hardly in keeping with the information available to the Committee from the world over.

Obviously the under pressure of the lobbies had caved in to the theory that the farm production could be sustained only with the full use of pesticides, withdrawal of which it was held out would lead to famines, hunger, increased imports and worse. To ensure food security, therefore, the bureaucracy had convinced itself and the political masters, the indispensability of pesticides and fertilizers. We shall touch upon the fallacies of these arguments when we review the IPM and the Organic Farming experience world wide highlighting the need for a National Pesticide Policy.

While discussing the dangers from pesticides which led to the setting up of the two Expert Committees it may be of interest to refer to the work of the NGOs and in particular to the Pesticide Action Network which has been relentlessly campaigning beginning 1987 with the launching of the Dirty Dozen Campaign highlighting the dangers from 12 pesticides, a list which was later enlarged to include 18 as already indicated. The Dirty Dozen Chart shows the progress, country-wise of the curbs imposed by various countries including India.

The review over the past few years after the beginning of the PAN campaign, does seem to show clear awareness on the part of the s through enlarging the curbs leading to placement of bans or withdrawal of registrations for many of these pesticides. While one would have expected a better, self-enlightened response from the policy and decision makers, nevertheless it cannot be denied that during the past few years the *Dirty Dozen Chart* in so far as India is concerned has certainly received a face list with the noose getting tighter on some of the pesticides listed therein. It is also of interest to mention that UNEP-ILO-WHO have been very active and alert and have recently updated the Guidelines on Classification as a part of their Internationaal Programme on Chemical Safety.[27]

It also seems clear that the progress is most significant where there are well organised public interest groups which have more often than not attracted public attention and

support through creation of public awareness and sustained campaigning–an effort which has had impact world wide through networking and sharing of information.

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Chapter 3
Why Opposition to Pesticides

We have so far touched on the beginning of the entry of chemicals in the traditional area of agriculture to control pests , which eventually led to the introduction of laws, acts and regulations to control these in view of the rapid use or growth of the pesticide industry, including imports. This use of heavy agro-chemical inputs received support from Government decision in 1966 or so to cut down imports of foodgrains. Incidentally India which had been receiving food aid grain imports through the PL:480 project after the Second World War had been taken off the guard and unprepared when the US Government chose to discontinue supplies of the foodgrains. This resulted in the country having to import foodgrains at unaffordable prices to keep the public distribution system from breaking down.

These imports in turn had gripped the slender economy of the country which it could ill-afford and the only solution seemed to be to increase production or starve. At that point of time the new Mexican Sonora, dwarf high yielding wheat varieties developed in Mexico by US Scientists caught the fancy of Indian policy and decision makers and an abrupt quick decision was taken to import these seeds and improve productivity by almost 2-3 times or more.

The imported seeds proved an instant success and the country turned the tide of fear to hope on the food front and this change has been referred to as the era of the Green Revolution. The catch was that the new high yielding varieties, first of wheat and then of Rice (from IRRI, Manila, Philippines) required extremely high inputs of energy, water, nutrients and plant protection agents.

Having said this we will limit ourselves to the high

costs of the use of chemical pesticides. Fortunately, the problems and damage caused in the country is claimed to be on a somewhat lower scale on account of lower levels of pesticide use (some 300 g/ ha as against about 10,000 g/ha in Japan). However, the advantage of lower use has been largely circumvented by lack of knowledge and training of a vast majority of rural farmers as also ill-informed population both rural and urban.

We will now try to answer the question, as to why world-wide, the use of these highly toxic chemicals which when introduced seemed to offer a panacea and a new hope for the world, are now opposed. On hind sight it appears that wrong assumptions and a failure to take cognisance of the plus-and-the-minus and largely on account of a desire to quickly obtain better yields which seemed to be the need of the hour had clouded wiser counsel. Let it also be said in fairness that the promoters by the early experience of improved yields were so taken up, that the almost prophetic early warning signals aired by the distinguished US Marine Biologist Ms. Rachel Carson, recorded in 1962 in her *Silent Spring* were ignored.

In fact she was decried and ridiculed in the process, as has been the case in many developing countries including our own. In some instances the affected manufacturers including the multinationals have taken recourse to harassment and even legal action against NGOs in the forefront of opposition to pesticides, as in a recent case in the Philippines, which eventually went in favour of the voluntary groups' right to express their viewpoint and to sharing of information on the dangers involved in use of any products put up for sale on the market.

It is now also abundantly clear that the main mistake appears to be that in our new found hope, very little attention was paid to the emerging damage and dangers which have now surfaced, leading to world-wide reaction, creating a strong drive to find safer alternatives to pesticides, which as we will see are becoming a cause for sorrow the world over.[1]

It may be worthwhile here to indicate the problems posed by pesticides which were identified as far back as 1962 by Rachel Carson–problems which as we will see have been further accentuated particularly in the developing countries

on account of the lack of knowledge on the part of the workers. The situation has escalated on account of an almost total absence of concern on the part of the manufacturers, the landowners, the administrators and the general public, all for a variety of reasons.[2]

This is borne out from the general knowledge that the affluent farmers first of all do not use the pesticides themselves on their farms but leave these tasks to their hired hands. Secondly, almost without exception, these farmers ensure that these pesticides are not used either on the crops or for storage for the farm produce meant for their personal use!

Reverting to the catalogue of concerns created by the continued use of pesticides, the experience gained points towards :

- Contamination of sources of water - both over ground or under ground-including the fog and rain-water.
- Damage to beneficial soil micro-flora including earth worms etc.
- Large-scale bird or fish kills including interference with reproductive functions in wild life.
- Contamination of food , including, animal feeds, soil and air.
- Serious health related problems with special risks to children.
- Resistance created in plants, pests and vectors of human diseases.
- Negative impact on plant biodiversity.
- Threat to ozone layer.

The net result is environmental persistence and bio-accumulation accentuated specially on account of overuse in homes, gardens, golf courses etc. Additional problems have been created by use of so-called 'inert' ingredients used in pesticides, specially in sprays.[3] The Coalition had brought out hidden widespread dangers posed by the common practice of using inerts without any declaration on the labels. Sandra Marquardt & her colleagues in a detailed report have highlighted the extent of dangers of these "toxic secrets" even though some of these are highly toxic-specially in combination.[4] Another difficulty has been created by the various isomers of

pesticides which remain as contaminants in the production process, some of which are inactive as pesticides but are far more toxic. Yet another related problem is that some of the breakdown products of these pesticides also turn out to be far more lethal than the parent compound. To add to these difficulties is the problem of synergistic action of some of these permutations and combinations. This results in significantly enhancing the health hazard of these chemicals. Yet another area of concern is the lack of availability of antidotes apart from the near total absence of Poison Reporting and Control Stations or early and easy access to sources of remedial information or treatment.[5] Moreover there are no easy means of fixing responsibility or accountability in such cases. Although India now does have Public Liability Insurance Act but it's implementation has been tardy and the process so long and cumbersome that only some very brave persons would embark on their use. This is in sharp contrast to the Right to Information Act which was sponsored and enacted in USA at the initiative of the US-EPA following the Bhopal disaster involving Union Carbide's Pesticide Plant.[6]

Broadly speaking as per WHO, pesticides are credited with causing some 20,000 deaths and 2 million cases of poisoning annually, largely affecting the agricultural and factory workers. As per estimates, at least half of these take place in the Third World even though the consumption here is only 1/6th of the total world use of 6.3 billion pounds. Incidentally US uses 2.1 billion lbs of pesticides each year while the annual global pesticide market is estimated at about US $ 26.8 billion.[7]

It is estimated that since 1945, over 3 billion tons of these toxics have been released in the environment world-wide. This has made them omni-present and persistent in the remotest areas of the Earth and invaded all life and elements including the air, soil, potable water, oceans, seas and rivers --human, avian and other animal and plant bodies not excluded. Likewise these highly persistent and not so easily biodegradable insecticides such as DDT have been found in the wild life of Antarctica, in the air and rain of even isolated Evawatak Atoll in the North Pacific.

Herbicide residues are also proving to be serious pollutants. The carry over residues have been readily detected not only in soil but US researchers have isolated these (e.g.

atrazine and alchlor) even in rain water at all levels-600 times higher than those ever detected for DDT, a common pollutant.[8,9]

One of the major concerns with these powerful agents is that these are general poisons and not selective in action for insects as well as for humans or animals in fact for all life. They have the power to kill, deform, mutate, induct sterility or cancer. For instance, less than one out of a 1000 kinds of insects are pests, but pesticides kill indiscriminately including beneficial soil organisms. Pesticides have also been linked with interference in the pollination process—through extermination of honey bees, butterflies, insects, sparrows and other birds.[10]

In the following, attention will be paid to some major areas of concern, specially where specific information/reports are available. This will be followed by a brief reference to isolated reports which may be of sufficient interest and may be indicator of future developments or directions.

Poisoning/Deaths from Pesticides

A reference has been made to the WHO estimates of poisoning or deaths which have been supported by independent studies of Oxfam and IDRC.[11]

There is a widespread feeling and concern amongst knowledgeable persons that these figures are a result of great under-reporting for a variety of reasons including a lack of diagnostic expertise amongst health and medical authorities . In addition, it is common knowledge, in situations such as ours in the Third World, that these occurrences are either ignored or hushed up by the employers on farms and factories, in order to escape responsibility for any compensation. Quite often such cases arising from accidental non-suicidal incidents could well be due to lack of knowledge and training as also unsafe practices in the storage, handling and use of these products.

Frequently long-term effects are seldom attributed to the use of these chemicals. This matter is also further complicated by the latent, cumulative effect of breakdown products of pesticides and their synergistic activity along with the effect of so called inert additives used in the formulations some of which are as undesirable or even more so than the pesticides themselves. Take for instance the now well

established inhibitory effect of the organophosphates and carbamate group of pesticides on enzymes such as acetyl choline esterase(AChE). Victims may have been exposed to pesticide doses without any symptoms or clinical signs, even while the depressed enzyme activity in the red blood cells affects the nerve endings of muscles. This eventually leads to giddiness, nausea, headaches, twitching of muscle and blurred vision. Often tightness in the chest, coughing and pulmonary oedema follow. This may also be followed by confusion and unusual bizarre behaviour. Although these acute poisoning effects are reversible but in some cases these may lead to longer term chronic effects including impairment of intellect, abstract and flexible thinking. Such effects are sometimes observed years after the exposure occurred. The damage and its severity varies from pesticide to pesticide in some cases leading to liver and other damages. It has been postulated that AChE inhibition possibly poses a greater human health risk, especially in areas where hunger is commonly prevalent.[12,13]

In fact both malnutrition and dehydration have been implicated in increasing sensitivity to pesticides which is believed to be further accentuated by higher ambient temperatures. For instance it has been shown in laboratory animals that the liver enzyme activity of animals with protein deficiency was more susceptible to malathion as against well fed animals. Depression of AChE activity by 30 per cent has been proposed as a 'hazard level' since acute clinical poisoning is expected to occur when the enzyme is inhibited by 50 per cent or more. In addition to the problem of enzyme inhibition, the organochlorine (OC) pesticides are also known to induce microsomal enzymes (the mixed function oxidases in the liver) thereby increasing the drug metabolising activity of the system.

What even partial conversion of a pesticide to its highly toxic isomer, on storage or otherwise, does is illustrated by poisoning by malathion of 2800 Malaria spraying workers in Pakistan with 5 deaths. The malathion had partially got converted into Iso-malathion during production and storage.[14]

As per WHO[13] several factors including the breakdown metabolites determine the severity of the effect in humans as also their persistence. A point of special concern to the Third

World is the importance of the health status of the individual as it has been established that malnutrition and dehydration are likely to adversely affect the individual. The fat soluble and even the water soluble pesticides enter through the intact skin which is an added danger in the developing countries where due to the warm climate protective clothing is generally not used. Yet another danger comes from the entry of aerosol droplets of size 5 mm in diameter or less directly in lungs through inhalation. The metabolism of the pesticides, for instance conversion of fat soluble pyrethroids to water soluble forms in the body helps easy excretion. On the other hand hydrolysis of carbosulfan as also furathiocarb convert these pesticides into more toxic and more water soluble compound, carbofuran. Likewise oxidation of thiophorous insecticides to their oxygen analogues converts them into more powerful inhibitors of AChE enzyme.

Some fat soluble pesticides such as DDT and HCH accumulate in the body fat and remain inactive; however during poor nutrition, the pesticides are believed to be released into the blood stream. It has been found that in rats on protein deficient diets, the lethal activity increases four-fold for DDT, 20-fold for endosulfan and a staggering 2,100-fold for captan. Dehydration and rise in ambient temperatures during summer adds to the intensity of the problem. There is also the problem created by synergism or potentiation of pesticides. For instance lindane and heptachlor in combination turn more toxic than each of these individually. Combination and interaction between pesticides containing a secondary amine group can result, in combination with dietary nitrites, into nitrosoamines, which may be not only more toxic but also more mutagenic or even carcinogenic. *In vitro* studies have demonstrated this to be the case in respect of 52 pesticides. Some of the recorded cases of breakdown products or metabolites and results of their exposure to sunlight and ultra violet (UV) light will be touched on later when dealing with the presence of pesticides in the soil.

There are reports of poisonings and deaths from all corners of the earth as brought out by WHO on the basis of verified reports. However, there are many doubting Thomas's especially in our country who, taking advantage of the lack of reporting infrastructure, firmly believe that the news of the poisonings and deaths are exaggerated. In any case, argued one major manufacturer at a meeting , such happenings

are inevitable in every situation and asked if we would stop driving or walking to work because an accident may take place? A valuable question indeed which illustrates the problems of the Third World almost ruled by a fatal combination of MNCs and indigenous vested interests joined together in an unholy partnerships for profits alone. Such is the wanton line of thinking even amongst those who ought to and do know better.[15,16]

In fact many people have been sold on the idea of these wonder chemicals as the only panacea for ensuring food security for the starving or underfed world. Quite often recourse is made to drawing the attention of the gullible to the looming famine awaiting if these chemicals were not used to control pests, weeds etc., little remembering the success of generations of farmers world-wide to feed the world by learning to live with these pests. Our protagonists also forget that the problem of pests has been grievously intensified as a result of use of these very chemicals leading to pest resistance and the connected problem of acute resurgence.[17,18]

For example even with a 10-fold increase in insecticide use in the USA from 1945 to 1989, total crop losses from insect damage had nearly doubled from 7 per cent to 13 per cent. World-wide that loss comes to about 15 per cent.[19] In fact the most telling example of this is the replacement of traditional corn-crop rotations in USA with the present continuous production of corn on about half of the original acreage resulting in a nearly 4-fold increase in corn losses to insects inspite of approximately 1000-fold increase in insecticide use in corn production. As we shall see later the benefits claimed for pesticides do not take into consideration the health and environmental costs, for instance in resistance in vectors or even the direct costs arising from resistance in plant pests. Claims of genetic engineering to rid the world of pest-resistance and other benefits will be briefly dealt with later.

The recorded damage to human health from pesticides is indeed very frightening depending on whether this is acute, sub-acute or chronic and this includes psychological symptoms, retinal damage, dizziness, loss of memory, miscarriages, intestinal problems, delayed neurotoxicity, sterility and birth defects not to forget cancer risks or suppressed immunosystem.[19]

There are also many problems and hazards on account of occupational exposure which may range from topical illnesses involving skin, eyes, headaches, heart palpitation and excessive sweating. US-EPA have for instance completed a listing of several pesticides with a high oncogenic potential. There are "30 probable human carcinogens" - in addition to 35 compounds "possible human carcinogens". In the former case as per US-EPA, there is sufficient evidence of carcinogenecity from animal studies with inadequate or no epidemiological evidence.[21]

There are 35 compounds classed in the latter group with limited evidence of carcinogenecity in the absence of human data. US-EPA's above classification relies largely on the work of the US National Toxicology Programme of the US National Cancer Institute which had carried out detailed clinical studies on 63 pesticides so far. Twentysix of the 63 pesticides were considered to show varying levels of carcinogenecity in animals. Such studies are subjected to 'peer' review. WHO have made out a list of 15 pesticides that need to be studied in the future as these are used extensively and are associated with recognised severe effects or on the basis of animal experiments or *in vitro* tests.[22]

While mishaps, which are very major ones or cause deaths are reported by the Press prominently, such as in the case of Bhopal, normally smaller mishaps go unreported or undetected as these are hushed up by the manufacturers. One such recent event was 3 deaths and 25 injured at Ghordha Chemicals in Lote, Maharashtra on account of release of poisonous acrylonitrile gases, leading to closing down of the plant. This incident was reported in Agrow on 23.9.'94. Although as reported, the plant was shut down pending Government enquiries, to the best of our knowledge the incident was not reported in the national press in the country.[23]

There have been many reported episodes of mass poisoning due to the consumption of food contaminated with pesticides in many parts of the world. One major case often quoted is that of the accidental admixture (1971-72) of methylmercury, a fungicide in the grain, which killed 400 of 6,000 admitted to hospitals in Iraq.[24,25]

Pesticidal mishaps in India have been reported from time to time although these are by no means complete in any manner.

The last major reported occurrence was of over 100 deaths in Basti, UP due to consumption at a wedding feast in April 1990 of wheat flour contaminated with BHC. Frighteningly it took 3 weeks for the public health laboratories to analyse the samples, much too late to help diagnosis or treatment with antidotes etc., or issue of warnings to consumers to prevent repetition or spread caution.[26] Yet as per a recent report Aluminium phosphide, the banned BHC & EDB continue to be freely available in UP markets.[27] In the Soviet Union, not unlike India, DDT though banned officially continues to be freely available for use.[28]

Despite very scanty, inaccessible records of poisonings or deaths, AIIMS records 11,558 deaths for 1982 in hospitals in India which was 25.8 per cent of the total of 44,732 of acute poisoning cases. This obviously excludes a very large number who never reach medical centres. Acute poisoning cases due to Organophosphates (OPs), carbamates have been widely reported from Ludhiana, West Bengal and Delhi involving diazinon, Baygon (a carbamate), aluminium phosphide and endosulphan. In just one sub-divisional Hospital of Murshidabad in West Bengal of 721 acute cases of poisoning, 639 or 88 per cent were due to OPs poisoning as per a 8- year study (1980-88). Carbamate poisoning accounted for 19 per cent, OPs 51 per cent and for the balance 30 per cent the exact agent could not be identified. In a recent study at the Government Medical College, Patiala, of the 110 cases in six months in 1989, 44.5 per cent were due to OPs, 20 per cent Aluminium Phosphide (AlP) and 16.36 per cent due to Endosulphan. As per the records of Medical College, Madras, of the total 518 cases of poisonings due to pesticides in 1990, there were 24 deaths. However, the details of pesticides involved have not been provided. According to a study in Amritsar District there was a 40 per cent increase in deaths from AlP, from 92 in 1992 to 107 in 1993.[26,29,30]

A one-year study of 3 hospitals in Delhi in 1990 also revealed a similar picture with AlP taking the cake. Incidentally cases of AlP poisoning and deaths have been reported time and again since 1983 from Rajasthan and several other States. Many of these incidence are due to pesticides—both accidental or suicidal. All this goes to show the total inadequacy of a reporting or notification system and lack of any organised Poison's Control in India. There is obviously similar lack of support by which analysis and identification of the pesticide

involved could be reached or help on the correct antidotes obtained.[29]

The list of incidents is almost endless and so is the list of questionable pesticides as probable or possible carcinogens or their specific involvement in reproduction disorders – which include alachlor and atrazine widely used in USA. Some other less familiar or known effects are also beginning to surface, such as the ability of organochlorines (OCs) to mimic the human sex hormone estrogen or prolonged exposure causing abnormal sexual development by enhancing or depressing growth characteristics in the reproduction system. The US-World Wildlife Fund (WWF) has released a statement signed by 23 leading North American scientists on April 20, 1994 warning against massive releases of large quantities of endocrine disrupting chemicals in the environment with harmful effect on the embryos. These have also been implicated in immune and thyroid system disorders, decreased fertility, gross birth deformities, disrupted sexual development. There is also decreased mating in birds, turtles and fish.[31,32]

Reports from the USA and 20 other countries show that sperm counts of men have declined by 50 per cent since 1940 and further, testicular cancer had tripled. There has been rapid rise in breast cancer. DDE, a DDT metabolite was also implicated in rapid rise of breast cancer (one in every eight women) with four times higher risk.[33,34,35,36,37]

Aerial Spraying—Dangers

The severity of adverse effects depends not only on the concentration and toxic nature of the pesticide but also on it's route, accumulation or persistence in the body. Pesticide intake takes place mainly through the skin or eyes, by inhalation or by ingestion. Pesticides, particularly the fat soluble ones are absorbed through the skin especially through sores and abrasions. The skin route has special importance in warm/hot climates or economic status of sprayers, who are mostly without clothing much less any protective gear.[38]

Air gets particularly contaminated during spraying operations specially during public health operations or even in situations such as the spraying inside of passenger planes. Pesticides have also been detected in unclean smog. It has also

been shown that droplets of pesticides evaporate and the tiny particles can be carried great distance, in air currents. It is in this manner that various pesticides such as methyl bromide have been found to be more dangerous than the notorious chlorofluorocarbons (CFCs) in causing hole in the ozone layer which in turn is associated with the phenomenon of global warming. For instance there are far studies which show that the pesticides sprayed on the walls of farm houses have been taken up by cows or entered milk in significant quantities throug, rubbing against the treated walls.[39,40] Aerial spraying leads to droplet vapour or blow (solid) drift and enables these to travel far and wide and appear in fogs, rainwater and get deposited again on land or water. In some instances, pesticide "fogs" have been reported to "burn" crops specially since these tend to get concentrated.

It has been estimated that not more than 10-15 per cent of pesticide sprays reach the target crop whereas hardly 1 per cent actually reaches the insect pests. Of late spraying of pesticides has come under serious criticism in the passenger planes since spraying of toxic pesticides in an enclosed area is highly objectionable. While pesticides continue to be promoted by the respective companies through various means, the spraying of aeroplane passengers on board with pesticide sprays has led to suits and complaints. The spraying operations become further intensified following any outbreak of epidemic or disease such as the recent suspected outbreak of plague in India which had led the airlines and possibly their countries into a frenzy throwing all caution to the winds.

This practice of aerial spraying inside aircraft cabins to kill undesirable agricultural pests or vectors which might be carried in the baggage or bodies of the passengers and the crew has been recently questioned and criticised in the US Congress and various US Federal agencies.[41] Strangely enough during such spraying the entire ventilation systems are closed down. In a recent case a New York passenger on a 1986 flight to Australia suffered injuries to eyes and face after a stewardess emptied 2 cans of spray over the passengers. This same passenger on another Australia-New Zealand flight was subjected to yet another spraying treatment and ended up in a hospital. Although she sued the Airways successfully, she lost on appeal in a New York Federal Court, despite the fact that the product used had a "hazardous to humans" label. The

label also carried a warning that this was not to be inhaled or allowed to come in contact with skin or clothing. Aerial spraying continues inspite of the advice from the scientists that the insects inside the baggage or inside wearers clothing are not likely to be destroyed unless there is a direct contact. It seems aerial spraying of planes is today a mere formality for the airlines as a method to buy peace with the local plant protection and health authorities.

In a detailed study and a survey conducted by the Consumers Union, New York, which entailed 158 flights both national and international, it was found that in some two dozen countries the pesticide aerosols were being used by the airlines with the avowed objective of destroying insects of agricultural importance and any possible disease vectors.[42] One such product in use was the Black Knight Roach Killer (d-phenothrin) which as per an initial US-EPA decision was considered safe. But later the reports both from the passengers and the airline crews had confirmed that the use of the spray led to nausea, seizures etc. which has led to a review of the product by the US-EPA.[43] The USA earlier required spraying on flights from some countries only in order to control rodents and plant insects, a practice that was abandoned in 1979. As per the Global Pesticide Campaigner, in 1983 the US Assistant Surgeon General had recorded that spraying inside the aircraft had never been shown to be highly effective in disease control or species containment and that the US could not support spraying while the passengers were aboard. However, even 12 years thereafter the spraying continues although in January 1994 the US Secretary for Transportation announced that the Clinton Administration was considering a series of steps to discourage some 24 countries from spraying the aircraft passenger cabins on international flights.[44] The US Government had also decided as a first step for US airlines to announce in advance about the spraying operations and permit those passengers with a medical certificate to leave during such operations. The US authorities it appears also wrote to the concerned Governments on the subject but what the response has been is not clear. Considering that some of the countries have been routinely spraying on all transcontinental and transoceanic flights with the avowed purpose of preventing dengue, malaria, encephalitis etc., and plant pests, and considering the bureaucratic nature of decision-making especially on

such sensitive issues, a quick response is not to be expected.

Thus pesticides continue to claim more victims even in the air under the mistaken belief in their ability to kill preferentially the unwanted insects and in the equally erroneous belief of their safety–obviously notions fostered and sold by the promoters. Possibly addition of camouflaging perfumes to the killer products makes peace with the passengers who are taken to believe that the pesticides are efficient, inescapable allies of the threatened man both in the air and on the ground.

In a recent instance in Mexico, the Government halted the spraying of 31,000 litres of 95 per cent Malathion solution over 39,000 ha of fruit and coffee zones to control the 'meofly' pest. OP pesticides have significantly been involved in risks of ill-health and in response 18 Mediterranean countries have recently decided to phase out OPs by 2005.[45] There have been sporadic cases of poisoning the world-over. For instance, in 1985 aldicarb in watermelons caused some 1170 poisonings in California mostly on the West Coast of USA. This pesticide is not registered in USA for use on watermelons.

In India, despite the lack of infrastructure for reporting under the Act cases of poisoning/deaths, there have been many cases as reported by the Government in the House of Parliament. As per Government records, as on December 21, 1993 as required under the law, of the 32 States, 24 had designated functionaries for reporting such incidents.[46] This is the situation even though the Insecticide Act 1968 came into operation in 1971. While under-reporting is almost a phenomenon in the Third World, in India, obviously the set up is particularly lax thereby putting in doubt the entire system.

There has been a general noticeable tendency for the Government to withhold whatever information may be available and by not insisting that the States or the Union Territories (UTs) comply with the requirements of the laws, the situation has been further aggravated. In fact there have been several instances where the Government has chosen to either withhold or delay providing such information or plead ignorance and in some cases provide coloured or inaccurate or incomplete information even in the Parliament.

Take for instance a question which came up in the Lok

Sabha on 16.12.93 regarding foetal defects in women as reported in the Press based on a survey conducted by Dr. S. G. Kabra and associates at the SMS Medical College, Jaipur, which showed that excessive pesticide residues in foods were cause of brainlessness at birth or still-births. The report has also observed that females were more vulnerable and predisposed to adverse effects of such poisons specially in the early stages of their lives in the womb. The survey of the Hospital records also showed 7 gross congenital defects per 1000 births.[47,48]

More than 80 per cent of these defects were of the brain and the spinal cord which developed from the neural tube in a developing foetus. The researchers ascribed these defects to the use of highly toxic WHO Class 1A pesticides viz., methyl parathion, phosphamidon and phorate commonly used in the survey area in Rajasthan where for Rabi Season during 1992-93 estimated 2,297 tons and for kharif season 902 tons were used. Despite the fact that a pointed reference was made to the above report in a prestigious daily of the capital, the concerned Minister disposed of the question in 10 words and to quote,' There is no epidemiological data to indicate such a phenomenon'.[49] And yet any elementary book dealing with pesticides and health would specifically confirm this phenomenon. But as recent as August 24, 1994 the Health Minister when asked whether pesticides caused eye diseases such as cataract as reported at a seminar of the Indian Medical Association, Delhi, the Minister had no hesitation in disposing of the query with a flat, "No, Sir."[50] And yet involvement of pesticides in causing eye diseases have been reported in detail extensively.[51,52] Further the Government on September 13, 1991, had told the Upper House of the Parliament that 'pesticides being toxic in nature can cause health damage including diseases such as eye defects etc.'[53] The Government had also on December 19, 1991, informed the House that pesticides were associated with abortion and premature labour in general population.[54] Once again on March 24, 1992, the Health Minister startled the House by stating that there was no evidence to indicate that pesticides were involved in causing the Handigodu Syndrome of Dwarfism.[55] Incidentally this was reported by the Indian Council of Medical Research (ICMR) scientists at the National Institute of Nutrition, Hyderabad, way back in 1977 and has been subject matter of public interest reported and commented

upon by several prestigious national media as also in various official Reports. [56]

The Government likewise made a short work of well documented reports of epidemics of epilepsy on account of accidental poisoning from wheat and animal feeds in the State of Uttar Pradesh which were reported by at least 4 groups of scientists at the prestigious Industrial Toxicological Research Centre (ITRC), Lucknow and K.G. Medical College, Lucknow.[57] It is no wonder with such a lackadaisical approach no serious efforts have been made to designate notified functionaries for reporting pesticide poisoning cases/deaths as required under Section 26 of the Insecticide Act. In fact as on December 21, 1993, these functionaries had not been named in 8 States as already indicated. Further it seems obvious as can be seen from the statewise data on poisoning or deaths in the possession of the Government that the functionaries appointed are not performing their duties which would explain perhaps why India is recorded as having the lowest incidence of poisonings and deaths in the world. Obviously the infrastructure needed does not exist so far. This is borne out by the fact that several medical R&D and teaching Institutions have reported a large number of such cases periodically.

There have been other sporadic reports of various incidents linking pesticides with various ailments. For instance Exeter University in UK confirmed the incidence of limb defects due to pesticides in 24 cases from seven coastal regions on account of exposure from aerial spraying.[58] In Venezuela on 20 February 1994 some 1000 persons were affected, to different degrees, when a truck carrying three tons of parathion, paraquat, aldrin, DDT, amidor, azcyclotin and zumilab spilled over a mountainous slope in Escaguey area.[59]

A study of family pesticide use in the form of 'pesticide bombs' in homes, for control of termites, in shampoos, flea collars on pets, use in gardens or orchards and for control of weeds, aerosols, found significant positive associations with childhood brain cancer.[60] Pesticide risks to children has once again been brought to the fore by Sue Dibb.[61] and reports of 3 recent studies in USA.[62]

A recent survey on the health of 1000 pesticide appliers in Minnesota, USA, pointed towards increase of chronic

disease amongst the applier group including 2 cases of hairy cell leukaemia. A possible case of Parkinsonism due to Maneb (EBDC) has also been reported in a 37 year old man.[63]

From UK reports have appeared alleging a possible link between fungicide benomyl and clusters of children born either without eyes at all (anophthalmia) or with syndromes like reduced eyes and blindness due to severe damage of the optic stem. In 1991 a benomyl preparation (Du Pont) destroyed large quantity of crops in USA leading to claims from farmers in several States of which 75 per cent were settled, obliging Du Pont to pay US $300 millions in damages. However the reason for plant damage was unclear.[64] Benlate (Benomyl) has also been implicated as a possible cause of severe plant damage of cucumber in Florida and other States including Hawai.[65] Analysis of information from New York indicates that where parents suffered from limb reduction defect due to pesticide exposure, the children tended to have these defects on a higher level.[65] New Zealand recently banned benomyl after 3 affected babies were born to handicapped mothers exposed to this fungicide.[66]

Reports from Cambridge University show that bumblebees and honeybees have been declining in UK on account of pesticide impact. As is well-known both these classes of bees play a very important role in agriculture by significantly improving the yields or quality of seeds or fruits and setting of seed itself through pollination. It is only recently that the economic value of honeybees as crop pollinators has been estimated but for the value of bumblebees there are no estimates available. Also value of bees as pollinators of wild flowers remains undetermined so far.[67]

Marion Moses has reported on two studies in US which implicate DDT as a possible source of breast cancer in Connecticut and New York States. From 1950 to 1989 the incidence of breast cancer increased by 53 per cent while mortality rates were increasing since 1940 by 1 per cent. While the cause was not established in 70 per cent of the cases, for the other 30 per cent, it was considered to be due to Xeno-oestrogenic substances which are from outside the body but mimic oestrogens as touched upon briefly earlier and Common amongst these pesticides are DDT, HCH, dieldrin, and heptachlor, most of which are banned in several coun-

tries. The writer quotes similar findings from Helsinki. These findings have also been substantiated by Ana Soto at Tufts University and these were subject-matter of hearing before the US House of Representatives on October 21, 1993.[68,69,70]

And now that the lid on information and news from China is partly off, comes the revelation that estimated 10,000 died in China during 1993 from pesticide poisoning. Most of these cases were due to neglect in following safety procedures and over-use.[71] In the Philippines, there were reports of 1303 poisonings from January 1992 to March 1993. Another study in Central Luzon showed a 27 per cent increase in mortality or nearly 900 farmers dying every year in one Province.[72] As per reports furaden-treated wheat fields in the southern state of Santa Catarina in Brazil has caused deaths of millions of birds.[73] A recent study of 103 couples in Austria shows that long term exposure to pesticide results in male infertility amongst agricultural workers by affecting sperm quality.[73]

Yet another study of 556 cases of poisonings in Brazil between March 1990 - March 1993 reports paraquat and parathion to be the main causes. The report revealed 46 cases of respiratory problems, of which 39 per cent died subsequently.[74] An EPA supported report from Japan links eye defects to OPs in agriculture, showing both myopia and Saku's disease—a more advanced visual disease syndrome. A recent US study also implicates, although not conclusively, pesticides commonly used in the homes, with brain cancer.[75,76,77] All these studies finally make out a strong case for pesticide reduction policies in order to reduce risks, which are under the circumstances quite difficult and expensive to establish.

A report comes from Hungary linking birth defects to use of trichlorofon whereas chlonitrophene has been linked in Japan to gall bladder cancer.[78] Another interesting case is a legal claim for damages in a Texas Court, by a group of Costa Rican farm hands seeking damages for alleged impotency and sterility caused by DBCP exposure. An interesting case reported was that of ex-employee of a giant UK pesticide spraying firm getting out of court compensation of US $ 90,000 for having developed cancer through use of PCP and lindane.[79]

An employee, Prem Singh at the Jawaharlal Nehru

University , New Delhi, encouraged by the above case has issued legal notice for damages to health suffered on account of spraying of aldrin during 1992 without any protective gear or clothing. Incidentally the use of aldrin has been banned with effect from January 1, 1994 in India.[80]

A report based on Hospital Records in Guatemala and other evidence indicates that in some agricultural areas over 6 people in every 1000 were hospitalised due to pesticide poisoning during 1986-90 although the actual numbers are bound to be higher. Forty one of these cases were due to occupational exposure and not suicides. Accidental poisoning due to consumption of sprayed vegetables accounted for 27 per cent and suicides about 16 per cent. In 1990, 1,080 people were hospitalised. During 1991, the Central Hospital in Colombia treated 122 cases of which 30 per cent were of occupational nature with a majority of them children, some below 4 years of age.[81]

An ex-employee in Manchester City Council was awarded US $ 65,000 arising from exposure to lindane used for timber preservation found in his blood leading to flue-like symptoms and post traumatic stress disorders. This is reckoned to be the first of its kind of compensation. OCs were also linked with agony and sudden deaths amongst tawny frog mouths in Australia.[82]

A 1992 report from IARC (International Agency for Research on Cancer) analyses some 20,000 workers from 10 countries over a period of upto 45 years, including factory workers and sprayers. Most common forms of chemicals used were 2,4-D; 2,4,5-T and contaminant dioxin (TCDD). Results indicate a high risk of soft tissue sarcoma over workers as a whole with higher risk for sprayers. There was also increased risk of death from cancers of testicles, thyroid and other endocrine gland and nose and nasal cavity.[83] Statistically significant increases in liver and biliary tract cancer amongst workers at an aldrine and dieldrin plant were also reported from US. The increase was nonsignificant in case of DDT plant.

From Hong Kong (1994) comes the report of poisoning from methamidophos-contaminated vegetables, which come from China (Shenzhen province). This has been happening since 1987 probably due to non-observation of safe waiting periods.[84] A musician in Hongkong has been awarded UK£

1.9 million for damage to hearing and nervous systems following spraying of the Concert Hall with Diazinon-an OP pesticide.[85]

Some of these recent incidents from the western world have been cited to show that despite strong NGO and public opinion presence and inspite of positive official responses and attitudes, the problem continues. On the other hand the situation is far more difficult in our country on account of the absence of such an environment, further worsened by lack of literacy and training at various levels.

Reference has already been made to some of the incidents in the country including information provided in Parliament. In addition there have been stray reports from Rajasthan, mostly implicating AlP poisonings. There have also been reports from Andhra Pradesh, including one where 16 farmers spraying lannet fell ill and were hospitalised. Pesticide poisoning claiming the life of 12 farmers was also reported in the *Indian Express* (22.7.1987) as also death of 6 children in Gandhinagar (*Times of India* 9.8.1986). Poisonings/deaths as reported at Madras Medical College, Madras from 1983-88 as also the results of a 10-year study of pesticides misuse as prepared by, the Government Forensic Science Laboratory, Bangalore, have also been documented.[86]

The foregoing demonstrates clearly that poisoning and death reports have not been recorded correctly and when this has been done as in the case of teaching and R&D Institutions, no effort has been made to collect and collate these at one central point. This would explain why official figures and statements have to be taken with a large correction factor to get an idea of the problem. In official statistics also it is clear that many of the States have put in nil reports which is well nigh impossible to accept.[87,88,89]

And now belatedly comes the news of a disaster at Anaversa, Cordoha in Mexico on May 3, 1991 when a factory manufacturing methyl parathion and 2,4-D and PCP, malathion, paraquat, BHC and lindane in a densely populated area surrounded by schools, churches and a prison went up in flames. Some 40,000 litres of these pesticides in stock are believed to have burnt yielding toxic furans, dioxins etc. Some 120 wells for public use were severely contaminated leading to more poisonings. About 759 patients were

diagnosed and a fair number of 1,064 living nearby were also affected. Another 236 patients were still with lowered AChE levels. Fifty-five percent of the persons showed persistent neurological damage, personality changes, depression etc. Thirty-six percent patients showed dermatological, allergic responses and significant weight loss. There is evidence of chromosomal damage leading to malformed babies. There have also been cases of anencephalism (babies without a brain), as also reports of malignancy and cancer deaths of 2 children, including leukaemia.

Another 44 year old woman developed medullar aplasia (a bone marrow disease) and a 65 year old man died of lymphoma. Thirty cases of malignant tumours in the area (population 5000) have been detected – eight of which were neoplasias type tumour, normally associated with pesticide exposure. The incidence in the area is far above the average anywhere such as 1 lymphoma per 100,000 people in USA . A significant finding was two cases of cancer amongst 60 fire-fighters who took active part and 3 malignancies in their families.[90]

Yet another incident is the Ciba-Geigy explosion and fire in Pakistan on April 11, 1994 needing 160 fire-fighters for 3 hours, many of whom later needed hospitalisation. Some 85 tonnes of formulated products worth US$1.2 million were burnt-monocrotophos (62 tons) mancozeb and metalaxyl (18 tons), cypermethrin and profenfos (3.8 tons). The Plant is located upstream from the wetlands of Layari river where salt mines are located.[91]

In June 1994 EPAs confidential summary of scientific re-assessment proved dioxin to be a serious threat to public health—causing cancer, reproductive and developmental and immune system effects which are even more serious than cancer itself. What is worse, there is no safe-dose for dioxins (TCDD) which comes also from polyvinyl chloride (PVC) and paper products, all connected to chlorine use.[92] The above US-EPA report has been released in September 1994, which showed that dioxins present a severe cancer risk ranging from 1 in 1,000 to 1 in 10,000. Dioxins enter the body through milk, dairy products, meats etc., which receive it from air through incineration of chlorinated material. More recently reports from Germany also associate Dioxins with cotton treated with pentachlorophenol (PCP) which is used for

transport of cotton. Incidentally use of PCP used primarily in leather was banned in India during 1993.[93]

A recent Report prepared by Greenpeace and PAN-AP, *Poisons in Paradise: Pesticides in the Pacific* (1993) reports incidence of 57 pesticides in 22 South Pacific Commission Nations, banned or not registered in other countries.[94] Groundwater analysis had revealed residues of paraquat, lindane and 2,4-D in Guam and traces of DDE in Tong . During 1970-84 the total number of recorded deaths was 45 in Papua -New Guinea and 210 in Western Samoa, compared to 15 reported deaths in Australia from 1971-80, with a much higher population and usage.

Retrospective cohort study examined the cancer mortality of 1,341 Dutch herbicide applicators who were reported to be highly prone to cancer. Sixteen different pesticides were found to be present.[95] An Indian study of a pesticide (DDVP) used in water in various combinations with n-heptane a petroleum hydrocarbon, cadmium, parnol (detergent) showed synergistic effect on aquatic life leading to reduced respiratory and feeding rates. 86OCs have also been detected in Mexican free-tailed bats collected from New Mexico and Oklahoma in 90-91. DDE was found in 40 embryos indicating that placental embryos offered only marginal protection for developing embryos.[96]

A report on an epidemic of 584 pesticide poisonings in north-west of Nicaragua during June-July 1987 showed carbofuran causing 77 per cent of the poisonings. Of the 91 percent of work related poisonings, 80 per cent occurred amongst maize workers, 19 per cent were children below 16 years of age.[97]

Pesticide Residues in Food, Air and Soil

As per available information one of the largest amounts of DDT accumulation in human adipose tissues has been recorded in this country. Various reports also show that 90 per cent of all food commodities are contaminated with pesticide residues—some above the Maximum Residue Limits (MRL) and some within it, depending on the results reported in various locations. On the other hand in the developed countries 80 per cent of the food is generally believed to be free from pesticide contamination.[98] Reference has already

been made to the adverse role of presence of pesticides in human bodies as antagonists to pregnancy, premature or still-born deaths or even in causation of epilepsy or Handigodu syndrome apart from many other ailments. Pesticides enter food either directly through spraying or other applications to crops or through uptake by the plants from the soil/water. This is in so far as agricultural foods are concerned. But meat, cattle, poultry etc., may pick up pesticides from cattle dripping or vector treatment. Pesticides also enter milk or the meat of animals through eating of pesticide contaminated feeds/grass. Fish caught from pesticide-treated-rice paddies may also contain significant levels of pesticide and even rivers where the pesticide overrun is known to contaminate the water and poison the fish.[99]

Food is also, not infrequently treated with pesticides during storage or transport or even for temporary gain of longer self life as in case of fruits and vegetables. Indiscriminate use or misuse results in high concentrations. In times of food shortages, it is known that pesticide-treated seeds have been consumed by man or domestic animals accidentally or otherwise leading to mass poisonings.

Indicators of exposure to pesticides and their metabolites is generally determined by the analysis of serum, fat, urine, blood or breast milk which is yet rather uncommon in developing countries on account of the high costs. Recourse is therefore taken to Acceptable Daily Intakes (ADIs) and Maximum Residue Limits (MRLs) in order to protect undue health hazards.

Maximum residue limits are the legal upper limits and have been fixed in respect of 50 pesticides registered in the country so far. MRL is the maximum pesticide residue (mg/kg produce) legally permitted in or on food commodities etc., under the Prevention of Food Adulteration Act, 1956 as amended from time to time.

These limits have been placed based on Good Agricultural Practices (GAP) which required pesticides to be used so as to leave the residues fall within Acceptable Daily Intake standards. ADI, basically a health standard based on toxicological information is the amount of a pesticide which can be safely consumed everyday by an individual during an entire life-time, with the expectation that no harm will result

to the consumer. Within the body, pesticides may be metabolised or stored in the body fat or excreted unchanged. If it is metabolised by the body, it may turn more water soluble and more easily excreted. For instance pyrethroid groups of pesticides which are fat-soluble become water-soluble in the body and are excreted.

On the other hand there can be increased toxicity on account of hydrolysis as in the case of carbosulfan and furathiocarb which produce more toxic carbofuran. Some of the metabolites of pesticides (e.g. thiophosphorus insecticide group on oxidation) become more potent inhibitors of acetylcholinesterase (ACHE) to which a reference has been made earlier. Loss of water in the body makes a person more susceptible to these pesticides as also higher ambient temperatures.

It has also been observed that DDT and HCH normally are stored in the fatty tissues but in times of low nutritional status of the body, these pesticides get released into the blood stream with possibility of high toxic effects. There is also the danger of synergistic interaction when 2 or more pesticides are ingested together as in case of lindane and alachlor and they turn more toxic. In some cases there is also antagonism and this leads to lower toxicity. While there is a mass of data implicating pesticides with carcinogenecity in humans but in the absence of clear evidence, these have been described as a potential hazard to human beings although carcinogenic to rats and mice. It is on the basis of this evidence over decades that WHO have classified pesticides according to degree of hazard to human beings under 4 categories extremely hazardous, highly hazardous, moderately hazardous and slightly hazardous based on the lethal dose values (LD50 values) in rats.

There are both national and international standards for pesticide residues in foods and farm products. A wide spread concern in the affluent countries has now led to demand for not only pesticide free organic foods including plantation crops but also feeds, fodder and importantly fibres like cotton and jute. These will be dealt with later in this monograph when we deal with alternatives. There have been a large number of studies in this country on the pesticide residues in foods, including human milk and feeds. Of late attention has also been given to water and to a limited extent to soil.

Contamination of human milk with OC pesticides has also generated considerable attention specially and some of these findings are given in the reports of the Indian Council of Agricultural Research and the Indian Council of Medical Research.[100,101]

India has also been a participant to some of these FAO-WHO sponsored surveys. More recently there has been a new concern generated on account of entry of GATT whose writ it appears will rule the roost. GATT is expected to adopt Codex pesticide residue levels in foods which are higher than the US-EPA tolerances as also those of the US Food and Drug Administration as can be judged from the data assembled by the Greenpeace. Such a situation will further increase the pressure of pesticides on human health and environment it is feared.[102] According to Dr. Mark Ritchie presently President Institute for Agriculture & Trade Policy, Mineapolis, USA, this increase would range from 1.5 to 50 times.[103,104]

While clear evidence based on effect of persistent presence of pesticides on human health is not available, the circumstantial evidence is not very re-assuring. Some of the reports link OCs to increased cholesterol synthesis, accelerated degradation of thyroid hormones leading to hyperactivity, impairment of immunological resistance in rabbits through decreased immunoglobulins and thymus atrophy in rabbits as also increased serum albumin levels.

A reference has already been made to several recorded cases of ailments and disorders arising from chronic effects of pesticides. A recent detailed report by the Indian Council of Medical Research detected DDT residues in 82 per cent of bovine milk samples tested and about 37 per cent were above tolerance limits, although the incidence varied in the 12 States covered in the study. Likewise analysis of 2,205 samples for HCH were also found to be contaminated in 85 per cent of the cases. High proportion of these (28 per cent) were above the limits fixed under PFA. Data on 186 samples of infant foods also showed presence of DDT in 7 per cent and HCH in 94 per cent, with 8 per cent of samples above the PFA limits.[100, 101] This is just confirmation of earlier results all over the country for milk and other farm products as also regular analysis of market food samples under the Indian Council of Agricultural Research. The work on residues in

foods under the All India Co-ordinated Research Project has been going on for over 10 years apart from other reports including the FAO and Pilot studies of Director General of Health Services (DGHS). A detailed study under PL-480 (1975-80) was also conducted at the Punjab Agricultural University on pesticide residues in foods and the environment. The results showed widespread pesticide contamination of foods including milk. Likewise soil samples—both agricultural and non-agricultural showed detectable levels of pesticides. This was one of the earlier systematic studies taken up in the country.[105,106,107] The pesticide residue problem has assumed terrifying importance on account of the now well known reports of the particularly serious dangers these pose especially to young children who are possibly more frequently exposed and in a vulnerable physiological condition

These dangers were brought out forcefully in a report entitled Intolerable Risk: Pesticides in our Children's' Food of the Natural Resources Defence Council, a New York based NGO. The NRDC had in mind the fact that children were in a developing stage with different dietary needs and metabolism and the fact that they generally received greater doses of pesticides through foods compared to adults.[108] Added to this was the fact that weight-wise they took more food and fruits, which were more liable to be contaminated. Further the data from animal studies had pointed that the young of a species retain a larger portion of any given toxins on account of better absorption and lower elimination. Further in the young the body detoxification system was not fully developed as in case of adults. Added to this was the knowledge that animals were found to be at greater risk of developing cancer if the exposure started in infancy.

The NRDC studied 14 pesticides and found that the children were more susceptible to 12 of these. Further review found that the young were more susceptible to 8 out of 10 carcinogenic pesticides examined. The release of the NRDC report resulted in immediate corrective changes from US-EPA and world-wide withdrawal of Alar pesticide by the manufacturers. There have been a few other reports on the subject including the finding that parental diet adversely affects the offspring. Consumption studies on contaminated fish from US Great Lakes fed to two groups showed that the group which ate contaminated fish from these Lakes had a lower birth rate, infants with unusually smaller heads and a

shorter gestation period. At seven months there was a reduction in these childrens' powers of visual recognition. At age four the latter group had losses in short-term memory when tested on both verbal and quantitative tests.

The NRDC report was rather alarming and generated public resentment and concern leading to the instant withdrawal of alar (daminozide) a growth regulant used widely in apples which breaks down to UDMH on heating during processing with sauce or juice. This is a chemical cousin of rocket fuel and its traces are found in Alar itself as contaminants.[109]

This report was followed by a study by a committee of the US National Research Council which submitted its 386 page report in 1993. The Peer Committee broadly accepted the findings and premises and assumptions of the NRDC report based on the data available from 1988 and earlier. In short it was found that the relative differences in toxicity between children and adults were about 10-fold. The report has made many far-reaching recommendations to deal with the problem of assessment of cancer risk. Yet another study on the subject was taken up by the Environment Working Group, an NGO based in Washington D.C.[110] Using data of 1990-92, it has come to the conclusion that the US-EPA has been seriously under- reporting the pesticide content since 5 of the 12 FDA Regional labs were obviously not adequately staffed or equipped. The Report also estimates that a large number of US children receive upto 35 per cent of their entire life-time dose of some carcinogenic pesticides by age 5 which is particularly so in the case of commonly used, Captan, Benomyl and Dicofol.

The Group recommends gradual phasing out the use of pesticides, developing of alternative pest control and access to organic foods or adoption of a voluntary, no-detected or ultra-low standard for pesticides in foods. Following these reports, the Clinton Administration issued a Joint Press Release from EPA, FDA and USDA on 25 June 1993 committing themselves to reduce the use of pesticides and to use both these 1993 reports as a basis for formulating future policies.

Such is the force of public opinion. In contrast, despite a high level public meeting organised by a consumer group in Delhi which was attended by the former Prime Minister V.P. Singh, Maneka Gandhi and MGK Menon, and

despite the wide press coverage it received, there has been no response from the Government far from having any right to information or any other positive response.[111]

Women and Pesticides

General reference has been made to hazards of pesticides specially in respect of children and women. It is now well-documented that women seem to be on the receiving end from the effects of pesticides quite substantially as a result of their work on the farms and the fields - specially on the plantations, such as tea, coffee etc.

Many of such incidents have been documented in Malaysia and more recently information is being gleaned from other countries where women form a considerable proportion of farm hands. These issues have been well-documented by Vasanthi Arumugam in a 192- page document which was also a subject matter of discussion at the National Seminar on Women and Pesticides held at Delhi in 1993. It is a pity that by and large official documents do not record the results of poisonings and other ailments sex-wise except perhaps in case of abortions and miscarriages.[112]

Women are the backbone of agriculture throughout the developing world. They produce 80 per cent of the food in sub-Saharan Africa, 46 per cent in the Caribbean, 31 per cent in North Africa and the Middle East and 50-60 per cent in Asia. Some 47 per cent of total agricultural force in India is women and some 3.6 million women are employed as agricultural labour, the highest level of female participation in South East Asia forming well over 75 per cent of the total work force in the country.[113]

Most of the women agricultural workers are in rice farms and plantations or they work in pesticide factories or formulation plants or pest control operations on the farms or vector control in public health. In tea plantations, which use high levels of pesticides in north-east India or Kerala, 50-90 per cent workers are women. They are also employed in cotton pickings which crop accounts for nearly 45 per cent of all pesticide used in India. This is equally true of other plantations like coffee, tobacco, cashew or spices where women are employed in abundance.[114]

A report from Nasira Habib of Pakistan confirms these dangers from pesticides in respect of picking of cotton

where women are the principal workers. [115]

As indicated, the studies in Rajasthan by Dr. Kabra and his team, had linked deaths, poisonings etc., amongst women/ children to the sowing seasons. Likewise studies in 1992 in Alibagh Taluk in Raigarh, Maharashtra, also show that 61 per cent of all infant deaths were during May-October—when even pregnant women are at work leading to premature deliveries and infant deaths aggravated further by poor nutritional status. Reports from ITRC, Lucknow, had also shown that OCs act as antagonists to pregnancy. Studies at Hyderabad have recorded abnormally high incidence of abortions among women and chromosomal damage amongst children. In Malaysia, for instance, 30,000 women work as sprayers and no wonder they suffer from exposure to paraquat etc. The ailments recorded are liver, lung and kidney damage, seizures, reproductive problems or even death, sometimes lingering in nature leading to cancer.

The results of a survey of 653 women across 13 States conducted by Sawhney and her students at the Lady Irwin College, New Delhi, on behalf of the International Organisation of Consumers Union (IOCU), Penang, were presented at a Seminar on Women and Pesticides in the Capital in December 1993. The results showed that while spraying was generally done by men, women did dusting of crops in many cases.[116] There were similar findings earlier in surveys conducted by Kothari and Joshi in Rajasthan amongst farm families.[117] In any case the task of preparation and mixing pesticides, filling sprayers and their storage and disposal was generally handled by women. Not surprisingly they had no training for these tasks nor for storage or disposal and they often used the discarded containers for water or storage of food stuff. Small wonder, women are the victims of breast cancer epidemic now sweeping the world-killing nearly 50,000 annually in US alone.

It has been established that women with the highest risk , 4 to 10 times higher, are those with OCs in their blood and fat. Women exposed to chlorine based chemicals in workplace have unusually higher rates of breast cancer. In Israel for instance breast cancer mortality rates have decreased after OCs were banned in 1970. OCs as pointed out earlier are also known to disrupt natural action of sex hormones and linked to widespread infertility and impaired development both amongst humans and wild-life. A woman's' life-time

breast cancer risk today is shockingly high–being one in nine.[118,119,120,120A]

Pesticides in Water

Information available in the country on the subject is rather sparse. However, following the studies undertaken under the Ganga Action Plan (GAP), fair amount of data has been collected which should have shattered the complacency of the authorities. It is clear that there is world-wide concern on the subject, leading to strong corrective measures in USA and Europe.

In India, some of the issues and dangers have been highlighted.[121] These concerns largely emanate from normal run off from farmland, slow and steady leaching which leads to contamination with pesticides. Studies under GAP show conclusively the presence of pesticides, in many cases above the WHO limits. Surprisingly no limits have been laid down for water in the country – or for that matter for soil or air so far, even though there is sufficient data both within the country and world-wide about the dangers. As pesticides enter water they contaminate fish leading to decreased production. Further these enter the human body or birds or wildlife through consumption. While the problem in fast moving streams/rivers may not be serious except during certain seasons when the run-off is considerable on account of farm use, the pesticides reach seas, oceans, lakes, streams, rivers and wells. Apart from this well-water and ground water get their share from seepage or runoff into ponds/lakes. A case of contamination of crabs and fish in a lake in Karnataka, consumption of which led to the Handigodu Syndrome (Dwarfism) has been well-documented in ICMR studies, although recently the Government has been side-tracking the issue.[122]

Extensive, uncontrolled use of pesticides world-wide has caused serious concern. The frightening thing about pesticides is that they do not stay in one place; pesticides infiltrate the surrounding environment and reach rivers, lakes, ponds and oceans through surface run-off from soil and plantations treated with pesticides, and through industrial and agricultural wastes. The degree of contamination varies, depending on the chemical structure of the pesticides. For instance 2,4-D is water soluble and thus more accessible to fish and wildlife. Pesticides like paraquat attach strongly to soil particles and may remain in the environment for a long

period of time.

A serious and largely irreversible aftermath of pesticide use is the contamination of groundwater. Some chemicals are known to travel as much as six feet down through the earth before these break down.[123,124] It is for this reason that chemicals banned in some countries , are showing up, years later, far away from where they were first introduced, through ground water contamination, seriously affecting fish and wildlife apart from posing danger to humans. There have been many recorded cases of large-scale fish kills, especially from the Great Lake States of USA and Canada.

There has been serious alarm over groundwater contamination with EDB used as a soil fumigant, leading to a ban on its use in USA in 1983. While freshwater fish seem to be affected rather dramatically, there have been many reports of poisonings of marine life also, especially from off the coast of some States in the USA. Pesticides have been detected in Malaysia in Padi fish which comprises 70 per cent of the country's protein intake. While in Thailand, millions of fish deaths were reported as a result of run-off from rubber plantations and were ascribed to Aldrin, Chlordane, 2,4-D, DDT, Paraquat, etc. This led to an estimated loss of about US$ 10 million to the aquaculture industry during 1982.

Monitoring of pesticide residues in water bodies in India has been an exception rather than a rule despite the ICAR's special report way back in 1967, by Prof. M.S. Thacker and an earlier report of the Shah Inquiry Commission instituted in 1958 when over 100 people died accidentally in Kerala after eating food contaminated with Parathion. The Thacker Committee had recorded several instances of pesticide poisoning of fish in water in Delhi, Karnataka, Pondicherry, Jammu & Kashmir (J&K), Maharashtra, Madhya Pradesh, Kerala and West Bengal. Most of these were caused by over run of pesticides from agriculture and public health spraying, or discharge from pesticide industries into rivers, lakes and ponds. In some instances, fish poisoning in wells was caused by washing of pesticide sprayers and other machinery in the wells. The Expert Committee of the Ministry of Agriculture in its 1985 report on DDT, records that not much had been done to monitor the pesticide residues in water bodies in the country.[125]

Pillai and Agarwal in 1979 found DDT residues in appreciable quantities in samples of Jamuna water drawn downstream at Wazirabad. Fresh water mussels, snails, prawns and many invertebrates collected there showed high DDT residues, ranging from 0.059 to 7.575 ppm (parts per million). The same was true of various fish species.

Lakshminarayana and Menon have reported high levels of DDT in crabs collected from paddy fields in Andhra Pradesh in 1972, 1975 and 1980. Likewise Kureshy in 1978 reported that plankton samples in the Arabian Sea between Bombay and Goa invariably contained DDT residues. HCH (Lindane) residues were detected (0.02 to 0.2 ppm) from ponds in the coffee plantation at Chikmaglur in Karnataka by Visweshariah and his colleagues in 1976. In the same area, drinking water was also found to contain the pesticide HCH in the range of 0.02 to 6.16 ppm in 1976. Analysis of 20 samples of water collected from Ludhiana and Muktesar also showed mean HCH levels of 0.9 parts per billion (ppb).[124]

It may be of interest to note that the total limiting concentration of pesticides (including its isomers and metabolites) in waste water of the pesticide industry has been fixed at 10 microgram/litre by the Central Board for Prevention and Control of Water Pollution. On the other hand, inland surface water is obviously expected to be totally free from any pesticides and the same is true of drinking water since no limits have been placed.

However, despite Bhopal, a *laissez faire*, attitude towards these hazards continues in our country. This is highlighted by the total lack of data on the subject — a case of blissful ignorance. In contrast, scientists in the USA, for example, have recently been analysing pesticides in fog, finding that some pesticides get enriched or concentrated 3,000 -fold in fog.

It is thus clear that increased use of pesticides and introduction of newer chemicals in the absence of a regular monitoring programme is exposing our population to new dangers and risks, as is apparent from the experience of other countries where these same pesticides have been used and in many cases banned or restricted .

An attempt will be made now to cite a few examples of the implications of occurrence of pesticides in water reported from various places to illustrate and highlight the implica-

tions of entry of pesticides, to health, to food production and to an extent food security, especially of the weaker sections, many of whom for instance depend on fish in their depleted diets.

A report on ecological impact on Kogalla lagoon in the southern part of Sri Lanka showed endosulfan, carbofuran, monocrotophos and dimethoate to be the cause of 2 fish kills in the lagoon. The contamination is also understood to have affected molluscs and crustaceans which are highly susceptible to pesticides.[125] In Costa Rica for banana productions, nematicides are widely used which during rainy seasons get washed into the canals on the Atlantic Coast leading to suspected massive fish kills, although no systematic anal ysis has been undertaken.[126] Reports from UK refer to the danger of entry of pentachlorophenol (PCP) (now banned in India), a highly toxic OC on UK's "Red List" which is widely used in the textile and leather industry which has been polluting the rivers. While UK Government has put some restrictions but these obviously are not functioning fully.[127]

Use of OPs (diazinon and chlorfenvinphos) has been quite common as a sheep dip water despite several incidents recently. In a recent incident a Welsh farmer has been ordered by the National Rivers Authority (NRA) to empty a pond on his land which he used to dispose of his sheep dip. The high contamination of the pond, it was feared by the NRA would overflow and pollute other water sources apart from its' leaching into the ground water.[128]

Concern has also been expressed in UK on the use of a "Red List" Dichlorovos for treatment of sea lice in salmon. Apart from being identified as carcinogenic by the US-EPA, there are reports of resistance to dichlorovos, for which reason alternatives are being developed. [113]

From France emanates the report of loss of 88 large pesticide containers in the sea carried on board a French Cargo ship in December, 1993. The smaller plastic bags contained metalaxyl, carboxin and furathiocarb made by Ciba-Geigy, some 7,000 of which were picked up in France. Thousands of these packets also touched Holland's' North Sea Coast, forcing the Dutch to seal off over 62 miles of their beaches. Some of these bags also drifted to five German islands in the North Sea. The vessel Sherbro was impounded and released by the Dutch after payment of US$2.5 million

as clean-up-costs.[129,130]

Pollution has also been reported of 2 Mexican lagoons the Carmen- Machona and the Alvardo in the Gulf of Mexico with DDT, lindane, HCH endosulfan and heptachlor. High levels of endosulfan were found in the oysters.[131]

A survey of 25 major Malaysian rivers during 1990-91 shows residues of DDT and heptachlor in most of these river waters. Rivers running through paddy areas had higher levels of DDT and endosulfan which exceeded the Malaysian standards of 4ng/1 and 10ng/1 respectively. Likewise levels of HCH, dieldrin and Heptachlor exceeded the levels prescribed for aquatic life in Malaysia.[132]

There has been widespread concern over the incidence of pesticides in human drinking water reservoirs in the USA . Gist of some of these reports will be cited here. Take for instance the report of Council for Agricultural Science and Technology (CAST), USA, which gives an overview of the picture.[133]

In the corn belt, atrazine, aldicarb, DBCP, EBD and dacthal have been detected recently but it is not clear since how long these have been present. The CAST report refers to the database of US-EPA covering 1971-91 which analysed 65,865 wells, 14.4 per cent of which (9,509) had concentration of 1 -10 parts per billion (ppb) and sometimes these go up to 100 ppb. These may seem deceptively low as the permissible levels range from 1 to l000 ppb depending on the active ingredient level. Some of the water species show a much greater sensitivity to some of the pesticides as many of the invertebrates are affected adversely at less than 0.01 ppb.

The US-EPA also found incidents involving pesticides in fish and bird kills and concluded that these incidents were more prevalent than was generally believed to be the case. Surface waters particularly lakes and rivers in the corn belt contained, atrazine, alachlor, cyanazine.[134]

In a case of metam-sodium spill in Sacramento river, the railroad operators in California had settled to pay US$ 40 million to the State of California and the Federal authorities for pollution caused by the spill of 19,000 gallons. This spill killed over 100,000 estimated fish in 1991. The main payout of US$ 35,000 will be made by the Southern Pacific Railroad

operators.[135]

Recently an unprecedented agreement was reached between US-EPA and USDA leading to the phase out of 36 pesticides under a legal settlement. The settlement also calls for a review within 5 years of 49 additional cancer-causing pesticides in order to fall in line with the Delaney Clause. The lead plaintiff in this case was Natural Resources Defence Council.[136]

The survey of ground water conducted by the North Carolina Centre for Public Policy Research shows that of the 45 States surveyed, pesticides in water were reported in at least 35. Of these, 27 states had Food and Drug Administration standards in force.[137]

Another survey conducted by the Environmental Working Group and Physicians for Social Responsibility showed that 14 million people in 15 States in the USA routinely drink water contaminated with 5 major herbicides. The chemicals detected were atrazine, cyanazine, simazine, alachlor and metalachlor. The farmers in these areas used 150 million lbs. of these herbicides on soybean and corn fields. Some 11.7 million of the people drinking this contaminated water lived in the States of Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Missouri, Nebraska and Ohio. The rest of the 2.3 million consumers belonged to the District of Columbia, Maryland, Pennsylvania and Virginia. It was estimated that 3.5 millions of these living in 120 towns and cities faced cancer risks that were 10-100 times higher than the federal benchmark. Some 20,000 test samples were taken from tap water, rivers and reservoirs used for drinking water resources. This has been brought out as a Tap Water Blues Report by the Environmental Working Group.[138]

The Great Lakes contamination in the USA continues to engage attention as nearly 56 million lbs of pesticides end up there every year–including 46 million lbs used on crops, 8 million lbs on lawns and more than 2 million lbs on golf courses. These remain there and are becoming more concentrated and have been the subject matter of an examination by US-GAO. Many of these are entering the fish and human chain. US-EPA estimates that 9 pesticides in current use may be more long lasting than thought earlier. There are fears that millions of lbs of unusable pesticides now being stored on farms in the Great Lakes region pose a disposal problem and may end

up in the Lakes.[137]

Another 2 alarming reports come from a consultancy firm, Disposal Safety Inc. in July 1993, which detected bromacil and oxamyl routinely in ground water at concentrations higher than the current 0.1ug/l limits set by the European Commission.[138]

WWF for Nature have expressed concern over the non-observation of the UK Red List Chemicals in the North Sea which is not likely to be enforced in respect of several pesticides which are not banned at present, such as Lindane. All of these were to be reduced by 50 per cent. Atrazine, Simazine and Dichlorovos seem to offer problems as these are in wide use in agriculture.[139]

Non-agricultural herbicides continue to be found in water as reported by Severn Trent Water, a monitoring agency in UK. The Unit is spending 100 million pounds over 4 years on granular activated carbon technology to remove pesticides from drinking water, about 2 million pounds for monitoring pesticides and 10 million pounds for removing them from water. The organisation has now developed technologies for the detection of diuron etc. at low levels. Concern for water contamination is world-wide as can be judged from a survey conducted in New Zealand by the Canterbury Regional Council. The first nation wide survey found 11 per cent of wells contaminated with atrazine, 2,4,5-T, 2,4-D, diazinon, chlorpyriphos, pirimifos-methyl, procymidone and other unspecified OCs and OPs.[140]

Somewhat cheering news emanates from the 4th annual Report of Drinking Water Inspectorate (DWI), UK. Out of 3.75 million tests conducted in England and Wales 98.91 per cent for all parameters of national standards 98.7 per cent showed compliance of the relevant quality standards. However some Welsh water samples contained glyphosphate and some dieldrin as also 2,4,5-T.[141]

Water contamination continues to be uppermost on the minds of NGOs such as the National Farmers Union (NFU-UK) which has proposed the possibility of buffer zones to prevent the entry of pesticides into surface and underground waters and to ensure maximum admissible concentration of 0.1μg/l is followed. In England and Wales during 1992, some 3.75 million tests were done by water companies. There was

an increase in the number of cases where the pesticides exceeded the prescribed limits—from 1940 in 1990 to 5061 in 1992.[142] The Director General , OFWAT, the water Industry watchdog in UK, has estimated that domestic water bills were likely to double up in order to meet the increased cost of cleaning drinking water.[143]

In European Community, admissible concentration is 0.1μg/l for any one pesticide but the total for pesticides is 0.5μg/l. However, this total limit rule has now been dropped. There is a strong feeling in the UK that pesticide content figures for drinking water of UK are underestimates, possibly a deliberate act. It has also been brought out that not all the pesticides are being screened.[144]

A survey by the National Farmers Union shows that 92 per cent of farmers disposed of paper and cardboard containers by burning, 6 per cent went to land fills and 2 per cent was recycled. Plastic containers were generally washed and re-used but 75 per cent of those interviewed burnt them. Ninety per cent of respondents buried metal containers but only 17 per cent burnt and crushed cans before burying them. The washing (or rinses) were disposed of by 71 per cent of those interviewed by putting washings onto the last crop sprayed; 56 per cent sprayed out on waste grounds and 8 per cent on low-grade wild-life areas. Only 1 per cent of the respondents had a Sentinel cleansing apparatus and a further 3 per cent of the respondents disposed of washings on set-aside land prior to ploughing or use unmetalled farm roads as a soak-away.[145,146]

The Pesticides Trust, London, has produced a new briefing paper on the problem of pesticides in water. As indicated the EC have now abandoned limits for total pesticides as this functioned as a crude protection against potential synergistic or cocktail effect of pesticides. This is a bit of a negative decision as in effect there will be no bar to higher total levels of entry of many pesticides in water provided they do not individually breach the present 0.1 litre threshold.[147]

Herbicide contamination has been a source of concern and some action not only for the North Seas but also for Mediterranean Estuarine Waters. A joint study of a pilot survey was conducted by the University of Loannina, Greece, Water Research Laboratory, Milano, Italy, the French Institute for Research, Nantes, France, the FAO Project Office, Athens,

Greece and the International Atomic Energy Agency at Monaco. This perhaps is the first extensive evidence of the presence of significantly persistent concentrations of herbicides in marine systems. The areas studied were Ebro delta on the eastern Coast of Spain, the Rhone delta in South France, the Po river in Italy, the Northern Adriatic Sea, the Thermaikos and Amrrakikos Gulfs in Greece and the Nile delta in Egypt. The herbicides most commonly found were atrazine, simazine, alachlor, metalachlor and molinate. In general, the aqueous concentrations encountered in the riverine inputs were comparable to (or below) those reported for rivers in the other parts of the world. In general the concentrations decreased from fresh water locations through estuaries to marine waters. The presence of some herbicides such as triazines in sediments confirmed the persistence of these chemicals. On the other hand herbicides were not present in samples from the Nile delta, for which only preliminary runs have been made. The presence of the herbicides are on levels comparable to other regions in the world. It has, however, been concluded that these levels are not likely to cause any acute effects on marine life or man. However, there is the potential danger of changes in phytoplankton communities which may occur arising from stress developed and this in turn may induce subsequent ecological changes.

In a related study undertaken at the University of Milano, Italy, a group of triazine herbicides were monitored in Po river over a period of 3 years. These studies did not reveal any significant degradation of triazine, indicating that these metabolites originate from the soil. In yet another study, Galassi and co-workers (University of Milano, Italy) detected OCs in surficial sediments of the Lakes- Gards, Como and Maggiare in Italy. It has been suggested that persistence of OCs as ubiquitous contaminants is due to their transport in the atmosphere over long distances. It has also been observed that lacustrine sediments represent a sink for these pollutants which can reach sediments through wet as well as dry depositions, tributaries or other local sources of pollution. This study also touches on the occurrence of Polychlorinated biphenyls (PCBs).

An attempt has been made at the University of Milano to develop biological methods for monitoring pesticides in order to decrease the costs of expensive, time

consuming chemical methods for pesticide determination. Further the present methods do not allow complete characterisation of all parent compounds and their metabolites. For these reasons algal growth inhibition test has been developed which it is claimed seems very sensitive for detection of complex mixtures as has been found earlier in case of industrial discharges.[148,149,150]

Loni Kemp of the Midwest Sustainable Agriculture Working Group in his January 1994 document, *Clean water and Thriving Farms*, refers to reauthorisation in 1989 of the Clean Water Act which was first passed in 1972. The main objective was to restore and maintain the chemical, physical and biological integrity of that country's waters. A goal had been set to eliminate discharge of pollutants in navigable waters by 1985. The third goal was to make all waters swimmable and fishable. A total amount of US$473 billion had been spent by the Government and the Industry to build and operate programmes for water pollution control.[151] Apart from pollution by fertilisers and livestock manure, sediment from eroding cropland and farm runoff, groundwater was also affected with 47 different pesticides in 26 States. Irrigation water discharged after it flows through farm fields, contains amongst other items, the pesticides. Irrigation run-off affects water quality, wetlands and wildlife.

Clearly, sustainable agriculture itself benefits from water quality. Unfortunately of US$400 millions assigned by the US Congress for the period 1987-92, less than half was actually appropriated for State programs. The progress made so far is not satisfactory. The report makes out a case for new policy approaches and directions, inclusive of action and incentives. It also calls for the removal of barriers and re-hashing of rules and regulations for implementation.Yet another report on pesticides in California ground waters reveals their detection in 80 wells in the State's 17 counties. The water samples were drawn from 2,324 wells in 45 counties. Of the 80 contaminated wells, 50 were for public drinking water and 11 were agricultural or industrial wells. Of the total 112 total ingredients and breakdown products for which these well samples were tested, 10 compounds were actually found. These were atrazine, bentazon, bromacil, diuron, prometon, simazine, xylene and TPA.[152]

The reports of contamination of foods continue to pile up world-wide. For instance a recent report from South India finds that over 50 per cent of the samples, tested for residues in market samples of vegetables, contained systemic pesticides beyond the safe limits laid down under the Prevention of Food Adulteration (PFA) Act.[153] In many of these cases the pesticides were applied just before harvesting obviously for cosmetic and keeping quality advantages. Lindane banned in several countries continued to be detected in milk in UK frequently over and above the maximum residue limits.[154] Similar concerns have now surfaced in respect of glyyphosphate, possibly world's largest selling herbicide (Monsanto). Although claimed to be safe by the manufacturers there are fears that damage to non target species, including endangered species will surmount, including development of the resistance phenomenon.[155]

In rural China heavy OP poisoning toll has been reported during 1992-95 with fatality rates as high as 24.7 per cent from use of methamidophos. These poisonings were on account of pest control applications and accidental poisoning amongst some 48,377 cases reported.[156]

Yet another report documents cases of occupational exposure and health hazards from fumigation of flowers in Colombia mostly for a thriving export trade.[157] The situation in this country would be if anything far worse, if data was available, with a flourishing flower market involving routine uncontrolled use of pesticides both for internal market and the substantial export market. There have also been Incident reports from USA which are a further cause for concern.[158]

Many of these issues have recently been highlighted by the workers world wide. These bring out the need for effective and swift policy decisions in order to offset the mounting dangers of the persistent organic pollutants (POPs) which include 9 organochlorines, although many more are on the active waiting list. A case has also been made out once again by Barbara Dinham[159] for a strict enforcement schedule for Prior Informed Consent clause. Such has been the concern amongst informed NGO groups that a global meeting of 92 countries was held in Montreal for initiating action for elimination of 12 such POPs world-wide.[160] Likewise Jules Pretty[161] proposes a 3- step framework for agricultural

change towards accomplishment of sustainable agriculture, an issue which will be handled later in some detail. The same writer in the meantime has made out a powerful case for establishing sustainable food system.[162] Both Beyond Pesticides Coalition[163] and the Voluntary Health Association of India [164] have likewise expressed strong views on the subject and suggested serious policy revisions. In the meantime a welcome news is that a common garden pesticide containing pirimicarb, triforine and buprimimate causing problems to eyes and skin has now been banned in UK.[165] In the USA, US$4 millions have been awarded as damages to a victim of benlate for eye damage and US$ 1.2 million to a victim of 2,45,5-T.[166]

Reference has already been made to the newly observed phenomenon of endocrinal disruption often caused by pesticides which arises from the fact that their molecules mimic natural hormones and act as such in the cell either adding to the natural hormonal process or competing with it. In fact this mimicking phenomenon came to light in 1991 while scientists were studying effects of synthetic hormone diethylstilbestrol (DES) used to prevent miscarriages in women.[32]

Barbara Rutherford quoting extensively from *Our Stolen Future*, an outstanding book by Theo Colborn deals in depth with the problem of synthetic, chemical, endocrinal disrupters.[167] Massive evidence has surfaced which shows conclusively that pesticides are threatening our fertility, intelligence and survival. The pesticides have already been linked with lowered sperm counts, increased testicular cancer, breast cancer as well as cases of undescended testes. At least 38 pesticides are considered to have reproductive and endocrinal disruptive effects. As has been already pointed out, many of these contaminants in foods and elsewhere mimic and or interfere with male and female hormones thereby modifying development and reproduction. Such hormonal disruption may also endanger populations by affecting their immune systems [168, 169, 170] a subject which has been dealt with in considerable detail by Robert Repetto who brings out that pesticides pose serious potential health risks through the distinct possibility of exposure through work or through diet as these seem to increase susceptibility to infectious diseases and certain cancers through suppression of the

body's normal immune systems. In an exhaustive analysis of the subject, Michel Smolen[171] presents consumers fears and makes out a plea for a concerted corrective action. Reference has also been made to a Citizens Conference held in March 1996 at Baton Rouge, Louisiana, USA, which was attended by some 550 delegates to make out a work plan aimed at elimination of endocrine disrupters. If this was not enough, now comes a report from the US researchers at Cuffs which shows that combination of environmental pesticide oestrogens can have synergistic potency which could be as high as 1000 fold with profound environmental implications.[172] Theo Colburn sums up the dangers observed world-wide from these endocrine disrupters and calls for restoring children's birthright of a healthy living.[173] Another crusader for women, Bella S. Abzug, President of the powerful Womens Enviorment & Devlopment Organisation (WEDO) likewise has pleaded for an early elmination of pesticides and other pollutants.[174] WEDO group have recently highlighted the grave body burden imposed by the POPs on women and have called for a unified, local, national and international plan of action.[175,176] Another Minnesota study demonstrates clearly that people living in agricultural areas were at risk of having children born with a range of birth defects and calls for reduction in pesticide use. The report also refers to the earlier studies in Iowa, Colorado and Nebraska in support of these findings.[177]

In UK , Buffin had earlier pointed out the mounting evidence of the adverse health effects of OP sheep dips on the farmers handling these jobs.[178] There appears to be a close links, as suggested by a dairy farmer, Mark Purdey between sheep dipping with OPs & bovine spongiform encephalopathy (BSE) which has had a catastrophic occurence in UK.[179] As per a recent study it has been found that heavy sheep dip pollution in 1997 has resulted in an extenstive damage to hundred of kilometers of rivers in UK.[180]

In the meantime, support to Purdey has emerged from the Institute of Psychiatry, London research, indicating use of phosmet, an OC pesticide may have made cattle susceptible to BSE.[181]

A report from Kent, UK, claims that use of methyl bromide, a fumigant may well have started that BSE epidemic.[182]

Alan Care now provides details of a case history which supports the earlier fears and gives data which seems to point a close connection of OP sheep dips exposure and heart disease confirming earlier reports of researchers in India.[183] These reports are in fact confirmation of the studies which had reported a wide range of oestrogen-mimicking compounds not only pesticides but also chemicals like dioxins, as also polychlorinated biphenyls (PCBs), alkyl phenols used in plastics as also some food wrappings as well as in paper, textiles, hair colourings and some toiletries. These chemicals have also been implicated in miscarriages, sperm reduction and several other reproductive angularities.[184] Some of these chemicals such as phthalates have gained entry in baby milks and foods through packaging.[185] Likewise controversy has been dogging soya based baby milk foods and other soya products which contain naturally occurring, heavy amounts of phytoestrogens which can mimic the oestrogens and potentially create the same problems that have been touched upon earlier, including delayed or premature menopause in women.[186] It is therefore no wonder that the various groups specially in the USA are alarmed and have set on a collision course with the policy and decision - makers on a matter of such intense public concern as brought out earlier. This may also explain in part such deep rooted public distrust, fear and the resulting opposition to the use of pesticides.

A recent statement of a UN Advisor, affirms that the pesticides are most serious environmental threat to the globe. It further acknowledges links between pesticides and multiple chmical sensitivity. This should prove a source of encouragement to the anti-pesticide activists and hopefully alter the present course of avoidable confrontation.[187]

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Chapter - 4

Pesticide Breakdown, Resistance and Resurgence

Pesticides are absorbed by clay and organic matter in the top soil (l0 inch)-but these go further down. There is also the dual porosity system which appears to be caused by the preferential flow of water and pollutants. These enter cracks and channels, in soil and in pores and fractures in rocks, according to Professor Keith Syres, Dean of Agriculture and Biological Sciences at the University of Newcastle upon Tyne, Northeast England. In UK the Government's Drinking Water Inspectorate took more than 500,000 samples and the pesticides exceeded the monitoring standard in 2.1 per cent, but all these were within the WHO limits.[1]

Pesticides may also enter soil when these are used to treat soil for control of insects, nematodes or plant diseases. Further some 50 per cent or more of the pesticides sprayed on crops or used as herbicides during spraying fall on the soil surface. Some of these pesticides also evaporate or volatatilise particularly during the spraying operations. The persistence of these chemicals in soil or their movement in soil depends on their chemical nature, type of formulation, including the solvents used, nature of soil, the weather, type of irrigation and also the biological agents particularly micro-organisms. Crops may also take up pesticides directly from the soil for example the carrots.

Some pesticides, however, become adsorbed on clay particles and organic matter in soils in a bound form which is not readily adsorbed and are not readily taken up by plants although these may gain entry into ground water supplies. Although there is a general feeling that pesticides in soil are not a serious threat to human health, but there have been cases implicating them in the contamination of fruits and vegetables as a result of uptake of pesticides from the soil.[2]

A survey of soils in Punjab during l976-77 revealed that 9l

out of the 106 samples from agricultural fields in Punjab were contaminated with the insecticide residues as reported by Kalra and Chawla.[3] DDT-R residues were found to be the most common, along with transformation products and the maximum level of 1.63 ppm was found in case of DDT-R. Other OCs were also detected. The highest mean level of 0.078 ppm of DDT-R was found in a cotton growing area in Punjab, 4 times higher than the mean levels of 0.017 ppm. This has been ascribed to use of higher levels of pesticide than recommended for cotton.

Later studies carried out using more sensitive methods of analysis showed invariable presence of both DDT and BHC residues in surface soils collected in villages of Ludhiana District in l980. The total official use of DDT for agriculture in Punjab was 1.5 tons as against about 700 tons for public health under the Malaria Eradication Programme which was on since 1962. The widespread presence of DDT could thus be attributed to this programme through environmental re-distribution and dispersion.[3]

A 1960 report from Pantnagar, UP had also shown that 87 per cent of the samples in that area were contaminated with DDT. Likewise it was reported that the entire soil in Delhi contained DDT residues ranging from 0.01-2.6l ppm with the highest concentration in Durganagar, Delhi, where the DDT Factory owned by the Indian Government was located. The comparatively low levels of pesticides in soils in India has been attributed by Agnihotri and Talekar to the faster rate of degradation under tropical conditions as compared to the colder western climate. This could also be due to comparatively very low levels used in India. The interpretation of Agnihotri has, however, been questioned by some other Indian workers.[4,5]

It may be relevant to point out here that the persistence of the OCs is bound to affect crops raised in such soils. Conversely, type of soils, organic matter content, clay content, nature of soil colloids, micro-flora in the soil, water and air flow, cropping practices, wind intensity, sunlight and not to forget rains, are also bound to affect the presence of pesticides in the soil. While Agnihotri has reported in 1977, the disappearance of gamma BHC in Delhi soil by about 97.7 per cent, within a period of 6 months after application, Chawla and Chopra in 1967 had shown that more than 50 per cent of the BHC persisted in the soil even after a lapse of 9 months. However,

studies show that the type of soil, water as in case of paddy, presence of organic matter etc., does show a wide range of variation as explained earlier.

In rice fields HCH has been reported to slow down the process of soil reduction thus providing essential nutrients to the rice plants. The reports on the effect of HCH on microflora has also been varied-- claiming both improvement in micro-flora or absence of it. In a study, dehydrogenase activity of soil micro-organisms in a flooded soil with HCH was found to be inhibited. Aldrin was found to be converted in soil to dieldrin. When applied to green gram aldrin was converted to dieldrin reaching a maximum on the 30th day after treatment. Of the residual dieldrin 80.8 per cent was degraded during the subsequent 70 days. Khushwaha and co-workers in 198l reported that even after 14 years the soil retained about 40 per cent of the aldrin applied. Studies in aldrin and dieldrin under aerobic and water-logged and other soil conditions did not seem to affect the nitrification process in soil.[6] Contrary to OCs, the OPs persist in soil for relatively short periods, although the nature of the soil had an important bearing. Several studies have established this finding. For instance parathion used in maize crops was in undetectable levels after three months.

While there have been many differing reports on the persistence of pesticides in the soil under Indian conditions the above report of Khushwaha is in line with findings of Metcalf in 1976 which would go to establish that pesticide residues of some of the more persistent ones remain in the soil for rather long periods.[7]

There has also been considerable interest generated in the nature of mode of breakdown of these chemicals in soil and the metabolites and breakdown products that are generated in the interaction, including their nature and toxicity. There has also been interest and concern on the effect of sunlight and natural ultraviolet rays as this has a bearing not only on the environmental safety but also their efficacy in the field It is now known that only some of the pesticides studied turn ineffective while several more of these, alone or in combination turn far more toxic than their original counterparts as can be seen from Table-1. This is based on the data of Parmar and Dureja [8], WHO , AICRP (ICAR), DST,CPCB and IARI, 1991.

Table - 1. Breakdown products of some pesticides and changes in their activity

Name of Pesticide	Breakdown products	Remarks
DDT	DDE, Chloral, chlorobenzene	4x more toxic
BHC	Benzene, chlorobenzene	
Carbaryl	Phenol, dichlorobenzene,	methyl
2, 4,D	Phenol, dichlorobenzene, 2,4 diclorophenol	isocyanate
Dimethoate	P2 S5, methylamine, methyl-iso butylketone	
Endosulfan	Hexachlorocyclopentadiene,, SOCl2 1,4 butanedial	Loss in efficacy on sunlight/ UV exposure
Malathion	P2S5, Diethylmaleate, dimethylthio-phosphoric isomalathion, acid, malaoxne,	Higher toxicity
Maneb disulphide	Ethylenediamine, Mn compounds,carbon	
Paraquat	Pyridine, dimethylslphate	
Fenitrothion	Paranitrometacresol	
Quinalphos	Diethylthiophosphorl chloride, orthophenylenediamine	
Phorate	Ethylmercaptan	
Aluminium phosphide	Red phosphorus	
Zinc phosphide	Red phosphorus	
Methyl parathion (60x more toxic than DDT)	PCl3, paranitrophenol	4x more tcxic
Iso proturon	Azo compounds	Higher toxicity
Dieldrin	photo dieldrin	10x more toxic
Heptachlor	heptachlor epoxide	Higher toxicity
Acephate	methamidophos	Higher toxicity
Synthetic pyrethroids	sunlight/UV exposure	More toxic, mutagenic
Phenamiphos sulphoxides, sulfones,	Azo compounds	more toxic
Dicofol	Photo products leading to	loss in efficacy
Aldrin	several products of concern	"
Chloropyriphos (Dursban)	"	some non toxic products
Phosphalone	"	
Propioconazole	Yields oncogenic metabolites	
Fenoproparthin	In soil and sunlight,several degraded metabolites are formed	

Several non persistent pesticides are hydrolysed chemically before the soil micro-organisms get to work on them. Thus the pesticides like dimethoate and fenitrothin generally seem to be persistent while dicrotophos persists in soil for about 75 days. Interestingly the process of degradation has been reported to slow down in the presence of fertilisers. While the persistence is dependent on the chemical nature, herbicides such as carbamates are recognised to be slightly to moderately persistent in soil. Organic herbicides normally do not build up their residues for more than a year at the common levels of usage on food crops.

It has been clearly established that a large portion of pesticides, irrespective of the type of applicator, the formulation or the crop/ plantation or even the public health application, eventually finds its way into the soil. The soil in fact serves as a sink apart from serving as a medium where various biological/ biochemical interactions take place. A large portion of the foliar and aerial sprays fall into the soil adversely affecting the non-target soil microbes, as also other forms of life in the soil. In fact these may also be taken up in the soil by plants or get translocated in the aquatic system by run-off or leaching and in the process, enter and contaminate the plankton, fish, invertebrates as also other forms of life. [8] As already referred to, the persistence of pesticides in the soils has been a debatable point under Indian conditions.

Translocation of pesticides from soil to plants has been reported in the case of aldrin to mung, lobia, carrot, raddish, beetroot and potato, both below and above the maximum residue limit. Translocation of BHC to the root crops is also true in case of sorghum plants and grains. Absorption is reported to increase 3 to 5 folds under certain soil conditions. Groundnut kernels as also its lipid constituents contained higher BHC than the laid down tolerance levels. It is thus clear that pesticides play a rather unwelcome role and enter the food chain and water, apart from affecting the biological habitat.[9]

A study on the impact of the contribution of agricultural application of pesticides on the quality of ground and river water throws considerable light on the incidence of pesticides. The study covers not only incidence in water but also in surface and sub-surface water as also fish and vegetables in the Farukhabad area of UP. The detailed study spread over three years was conducted at the Indian Agricultural Research Insti-

tute New Delhi by N.P. Agnihotri and his team sponsored under the Ganga Action Plan by the Department of Environment. The study brings out that the use of pesticides in the area has gone up sharply in three years by six times. A total of 25 pesticides including 14 insecticides, 7 fungicides and 4 weedicides were being used in agriculture adding up to a total of about 1,80,000 kg of active ingredients.[10]

HCH was found to be invariably present and in surface soils the range was 0.014 to 0.0158 μg/g and from 0.012 to 0.067 μg/g in subsoil. DDT with its many isomers was found almost in all surface and sub-soil samples throughout the year. Aldrin and dieldrin were also detected ranging from 0.005 to 0.017 μg/g in surface soil and 0.008-0.015 μg/g in subsoil water. Residues of endosulphan were detected in surface soil (0.002-0.190 μg/g) and in subsoil it was 0.002-0.093 μg/g. Heptachlor was detected only in a few samples.

Malathion and monocrotophos were commonly detected—the range being 0.002-0 016 and 0.002-0.014 μg/g for surface soils respectively. For sub- soil this was non detectable (ND) - 0.004 and ND-0.008 μg/g. Lindane at Farukhabad persisted in soil for about 30 days after application. Endosulphan was lost by about 33 to 38 per cent in 7 days, 68 73 per cent in 15 days and in 30 days this was 86- 89 per cent. A similar picture emerges in the case of deltamethrin. It is thus clear that pesticides are closely linked with water, soils and air. The breakdown of pesticides to various isomers presents many other serious latent hazards making pesticides highly unsought commodity.[11,12]

Resistance in Pests

As we have seen, pesticides have turned out to be a dreaded word in view of their adverse impact on life belonging both to plant and animal kingdom. The use of pesticides to control undesirable pests of importance both in agriculture and human health has received a further setback as a result of the development of resistance to pesticides in pests and vectors. To add to this problem is the comparatively recent phenomenon of resurgence.

Thus the hopes that the advent of pesticides had evoked both for food security and public health have received a serious setback on account of unprecedented rise of resistance in insects, plant pathogens and vertebrates. This is also true to a

lesser extent for weeds. Resistance to pesticides is now believed to extend to fungicides, bactericides, rodenticides, nematicides etc. Thus pest resistance is no longer the farmers' concern alone as it transcends much larger dimensions and has been engaging the serious attention of policy and decision makers and R&D scientists apart from the industry.

Unfortunately very little attention seems to have been paid to this problem over the years and it is apparent that we have not been profiting from the experience and scientific findings elsewhere. Very recently however there has been a perceptible change and atleast two reviews have appeared–one covering pest resistance [13,14] and the other one on pest resurgence. [15] The lack of information as also the results of any sustained work in the area can perhaps be judged from lackadaisical reply to a question on the subject in the Lok Sabha on April 23, 1992.[16] The M.P., Dr Ravi Mallu wanted to know the full details of plant and vector resistance and the steps proposed by the government to deal with the situation. While acknowledging the incidence of resistance in the country, it was stated by the government that in India a total of 27 insect pests and vectors were `reported' to have developed resistance to various pesticides. Out of this 14 were vectors and pests of public health importance and 13 were pests of importance in agriculture. Obviously this reply was based on the information provided by the Indian Agricultural Research Institute, New Delhi, presented at a Workshop organised by Consumer Education and Research Centre at Ahmedabad in 1989. This had documented the occurrence of resistance in respect of pests of importance in public health, agriculture and storage of farm commodities, mostly grains. Some work in this area has also been done by the ICMR scientists at Pondicherry and Madurai apart from some reports from the Malaria Programme at Delhi of the Ministry of Health. One can only deduce from these reports that various pests in India have remained dormant and subservient to the powerful pesticide manufacturers lobby and pesticides of Indian vintage unlike their western counterparts. As can be surmised from a recent review on the subject[14] there seems to have been no increase whatsoever in the number of pesticide resistant species or any clear evidence of increased resistance amongst the already known species, unlike in the West where the situation has been causing a serious concern. Incidentally over 1,000 species

have been identified as pesticide resistant elsewhere and the list of the tribe is growing.[17,18,19]

It is true that while resistance was a rare phenomenon during the early fifties the opposite has turned out to be the case in the eighties. However, the phenomenon of resistance was first recognised some 85 years back although it has assumed serious proportions since the advent of chemical organic pesticides some 45 years ago.[17]

Resistance in plant pathogens turned out to be a threat since mid-sixties and has gained strength after the entry of systemic pesticides (fungicides) some 20 years back. Resistance has grown in weeds treated with herbicides and same is now the case with rodents and this is indeed the picture all over the world. It is therefore a bit of a sad story of our scientific status which claims to be one of the top in terms of statistics and of scientific personnel, that our pursuit of knowledge is so slow and erratic and obviously devoid of any direction. The situation in respect of the collation and collection of data on the cases of pesticide poisoning in the country is also a case in point which illustrates our unscientific approach to many of the contemporary problems.

In contrast as per documented and informative records in USA, resistance in mites and insects rose from 7 DDT-resistant species in 1938 to some 447 resistant species to the principal classes of pesticides in 1984. Nearly 97per cent of these are of importance in agriculture and the veterinary field. About half of these were resistant to more than one compound and at that point of time 17 species could resist all the 5 classes of pesticides. The picture has no doubt worsened since this excellent review was brought out in the USA by the Board of Agriculture which is a part of the US National Research Council. As indicated above over 1000 species are recognised to be pesticide resistant at present posing a formidable task to the R & D establishments world wide.

Resistance has also been recorded in at least 100 species of plant pathogens particularly to fungicide benomyl widely used in the USA. To add to this not very cheery picture is the knowledge that some 55 weed species had turned resistant primarily to the triazine group of herbicides in addition to 2 species of nematodes and 5 species of rodents.[18]

In the earlier stages it was the problem of pest resistance

to one pesticide whereas the picture has changed and become a bit worrisome on account of poly- or cross-resistance which has made the problem of resistance more daunting and difficult to handle. As is clear now, problem of resistance is no longer limited only to insects but covers almost the entire range of living organisms and almost the entire range of xenobiotics devised by man to promote and protect its immediate needs and requirements in the area of human health and farm production aimed at banishing hunger and need. The chronological increase in number of resistant species upto 1984 should therefore convince us of the seriousness of the situation confronting us today. In case of resistance to the anticoagulant warfarin, this was first reported in 1958 as the 'Norway Rat' in the UK. Later this was reported from the USA in 1970 and since then it has travelled far and wide, although it is general knowledge that the actual incidence would be far greater. Certainly the figures for India cannot be accepted at their face value on account of the lack of any reliable or regular studies conducted on the subject no doubt on account of a variety of reasons, such as lack of advance planning and thinking, foresight and lack of direction as also misplaced priorities and acumen. Obviously our efforts seem to be directed largely towards the release of new varieties of crops, an area which seems to provide honours and recognition to our scientific workers. A break-up of the 447 resistant species and the 5 chemical groups of pesticides to which these have been found to be resistant should serve as a sufficient warning for those leading our R&D establishments.[19]

As indicated[14] details of 13 pesticide resistant pests of public health as also of household and veterinary importance have been provided indicating the year these were first reported in the country. The author has also referred to the history of resistance of vectors of dengue fever, malaria and filaria in the country. A reference has also been made earlier in this review to the resistance developed in the household pests including the common housefly which has become quite widespread in the country. Yet another insect pest of veterinary importance is the resistance in cattle ticks, a resistance that has been estimated to be about 6 times higher.

Resistance has also been recorded in India, only in 5 pest species—singhara beetle, tobacco caterpillar, diamond back moth, mustard aphid and the American bollworm. Except possibly

for cotton pests, resistance recorded is largely to DDT and BHC, confirming the earlier observation that hardly any serious attention has been paid to the study of this problem. In respect of stored grain pests, high levels of resistance have been recorded, 16 to 35-fold increase in case of malathion as also to AlP in case of Khapra beetle which was found to be as high as a 40-fold increase. In both these instances the level of resistance as reported is a matter of serious concern. The resistance of *T. granarium* to phosphine is a matter of concern to our establishment and trade as the incidence of this pest is likely to dampen prospects for exports of the infected grains.

It is in this background that there are plans to adopt an Integrated Resistance Management (IRM) approach aimed at controlling rates of application, doses and periodicity of pesticides. It is clear that there is considerable scope for an intensive scientific input to probe into the realm of mechanism of resistance under our own set of working conditions, although certain amount of studies were taken up in respect of cross - resistance to DDT. Likewise there are reports of isolated work in respect of pyrethroids in order to reach out at the mechanism of development of resistance although one main mechanism is through the breakdown of the pesticide itself.

The proponents of the IRM also make out a case for a close study of the IPM on a priority basis as in their view this offers a viable basis to ensure food for all and a meaningful and possibly workable system of food security. The situation created by pest resistance is forcing and encouraging recourse to newer and better and even more powerful types of chemicals which is keeping the commercial manufacturing Houses and their R&D laboratories more than busy. However, one strong constraint of late has been the present impossibly high costs of R&D which has been brought about also on account of the high level of cross- or poly-resistance which has been serving as a damper for these laboratories.

The reluctance of manufacturers to invest on R&D is in part possibly due to the strong public and consumer outcry and resistance to intensive and uncontrolled use of these chemicals which is aggravated by the fact the philosophy or mode of action of these chemicals relies on their highly lethal action and power to kill generally and not selectively. Public resistance has been heightened on account of many serious accidents and ill effects of these chemicals not only on human

life but wild life, the environment and ecology.

It is this situation which for instance led to the launching of a highly effective and successful programme of the Dirty Dozen by the Pesticide Action Network of the International Organisation of Consumers Union based at Penang, with a world-wide network of consumer bodies and activists. This in turn through creation of a keen sense of awareness has made the many governments to sit up and take note. It also seems clear that the prolonged and persistent use of these chemicals has in many instances led to ever increasing levels of resistance thereby requiring additional doses and concentrations and quantities of these chemicals making their use not only counter productive but far more harmful and difficult to handle in the field and also adding to increased dangers for the environment and the poisoning of the Earth.

This is also borne out by the continued effectiveness of some of the pesticides where some vectors are still under check with the use of these chemicals arising possibly from moderate and controlled use, an approach which unfortunately is missing and perhaps it would not be possible specially in the background of vast illiteracy and poverty apart from the lack of infrastructure for training. It is also true that even the newer group of compounds introduced after the OCs and OPs began to fail, that the high costs of these is far beyond the capacity of the vast majority of the farmers to afford, despite the heavy and latent subsidies provided by the government in many instances. It is in this context that farmers and the governments in not so affluent situations such as in India are not too eager to switch over to more expensive OPs etc., even if these may be more effective and less toxic. In fact some of the surveys conducted in this country conclusively demonstrate that despite the much higher levels of OCs needed on account of the resistance in pests and inspite of their ineffectiveness to control the particular pest(s), the resourceless farmers are unable and/or unwilling to switch over even to the official recommendations of the respective extension wings most of which are now based in the over 35 agricultural universities in the country.

In any case these considerations apart, in some incidents of bollworm outbreaks on cotton in Andhra Pradesh and Punjab it would seem that even some of the official recommendations, implemented at high costs through special im-

ports of newer types of pesticides had not been successful. Some of these were not even registered in the country, but were imported under special powers and dispensation of the Government, but failed and went haywire, breaking the confidence of the farmers leading some of them to suicides. This therefore makes pest resistance a serious problem indeed drawing attention and focus of farmers/Government to the possible alternatives including IPM for minimising the hazards of the new but doubtfulera of chemical poisons. This will be dealt with some detail separately.

So far we have dealt with the problem of accumulation of pesticides in soil as also the problem associated with resistance to pesticides and referred to the related problem of pesticide-induced phenomenon of resurgence which is also often referred to as flare-back of the target pests following the application of pesticides. Thus by resurgence is meant an unusual or abnormal increase in the pest population quite often beyond the economic injury threshold following the application of pesticides. This increased insect population is often accompanied by increased damage in pesticide treated areas. Continuous use of pesticides over long periods is believed to lead to the problem of resurgence.

Farmers tend to increase both the dosage and frequency of pesticide use if they find that pests are not responding to the application of the usual doses of pesticides. Quite often, such a failure leads to use of another pesticide or a combination of these.

Such a situation leads to the problem of resurgence of target pests and also the development of resistance, leading to a weaker control of pests not normally found, with an out of proportion increase in the pests. For instance the International Rice Research Institute (IRRI) studies show that the ineffectiveness of diazonin in relation to brown plant hopper was on account of pest resistance. This has been ascribed to the detoxification of the insecticide structure by enzymes like carboxyl esterases, oxidases etc.

Two types of resurgence have been observed–one is the observation that the pest populations overcame excessive levels within a relatively short time, after these were initially suppressed by the application of pesticide. Secondly the unimportant target species develops into serious pests after

insecticides were applied for control of another target species. A survey of several outbreaks shows the misuse of pesticide application. The pest resurgence has been linked with the widespread mortality of natural enemies, reduction in competing pest species, feeding and reproductive stimulation of target species. Additional causes such as changes in the nutrient content of the host plant, the inherent quality of the pesticide, use of underdosing, resistance level of the host plant and some other related causes were also identified.[19]

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Chapter - 5
Poisons Control and Vector problem

Suppression of natural enemies is one of the major causes for insect pest resurgence. Quite often this assumes unmanageable proportions especially in rice after the use of broad spectrum insecticides. This has been demonstrated in the case of brown plant hopper resurgence in rice after regular sprays with methyl parathion, although this finding has been questioned by some.[1]

Pyrethroids have also been implicated in the destruction of predators. A similar resurgence of mite due to destruction of natural enemy has been reported in cotton. There are many such recorded instances such as in the case of grapevine mealybug. Use of almost all insecticides, including neem preparations have been found to lead to resurgence.

An interesting observation has been the improved feeding rate of brown plant hopper with sublethal doses of insecticides and also higher reproductive rate. There are similar effects due to the sex ratio which was found to be in favour of females in most of the cases studied.

Yet another factor was the resulting increased growth of the plant, including tillering as in rice plants after insecticide use. This in turn attracted hoppers in the rice fields, leading to resurgence.

With the use of insecticides, the nutritive quality of host plants seemed to be altered in favour of insect pests thereby encouraging resurgence in pests. This has been shown not only in case of brown plant hopper in rice but also in cotton, bhendi and apples. As referred to earlier, the rate of application of pesticides, the timing, number of applications as also mode and method of application, such as foliar or root zone application or broadcasting etc., had an effect, with foliar

spraying resulting in the highest resurgence. Insecticide use often helps the displacement of competitive pest species, resulting in resurgence, as for example in the case of sugarcane scale while using endrin which was used to suppress the top borer. Varietal resistance of crops also counts; in general resistant varieties do not induce resurgence as has been found in the case of rice and other crops.

To overcome resurgence, various methodologies and regimens have been suggested in order to keep this situation under check. These include insecticide management, use of resistant cultivars, monitoring of insecticide resistance not only on a particular farm but across geographical boundaries. Sparing use of insecticide, as in case of IPM is recommended. If resurgence is to be controlled, it is important that farmers do not aggravate the problem through excessive and frequent applications. As it is the developmental cost of a new insecticide to meet the stringent requirements are already forbidding, having increased from an estimated US$ I million in 1956 to about an estimated US$ 20 millions in 1977. As per the Industry view only 1 in 25,000 chemicals screened pass the stringent test for being registered as a pesticide. The mechanism of insecticide resistance has been studied in India on a very limited scale but as indicated this has been ascribed to the conversion of the insecticide to which they were susceptible into an ineffective metabolite.[2, 3]

It has also been suggested, on the evidence available, that in the high yielding varieties (HYV), higher doses of fertilisers, increased irrigation and pesticide use has precipitated the resistance in insect vectors of public health importance. It is now generally accepted that the use of pesticides in public health operations has directly resulted in the appearance of pesticides in bovine milk.

Resistance of vectors to pesticides continues to be worrisome as it affects spread of disease and affects disease control programmes around the world. Resistance now covers all the commonly used pesticide groups and there are indications this now covers the juvenile hormones, diflubenzuron and even certain strains of *Bacillus thuringiensis*. There is also the serious problem of multiple resistance in malaria vectors *Anopheles*. Same is true of the common *Culicines* and even the house fly and cattle tick.

Certain larvivorus fish populations in the USA and else-

where are reported to have developed multiple resistance. Rodenticide resistance is yet another important area of concern although alternative rodenticides such as the new anti-coagulants are now available but somehow this subject matter has not received adequate attention.

The resistance to pesticides in mosquitoes, flies, lice, bedbugs, fleas, cockroaches ticks, apart from other non target species like fish etc., has been world wide. However, on the situation nearer home, that is the South East Asia Region, where 9 countries have endemic malaria despite (or because of) extensive and intensive use of residual insecticides to eradicate or control this menace for about the past 4 decades. While initially this treatment seemed to have worked in controlling the vector population, by the mid-sixties the incidence of malaria rose from 100,000 cases in 1969 to a high of over 7.2 million by 1976 which rose again to an estimated 1 billion by 1984. [4]

Of the nineteen anopheline species which are primary or secondary vectors of malaria resistance is known in 3 species. In India (1984) DDT resistance of the malaria vector to one pesticide has been reported from 18 States covering a population of over 262 million. However, the situation has worsened since and in 1989 the main malarial vector in India, *A. Culicifacies* was reported resistant to DDT, malathion and dieldrin in 62 districts in 6 States and one union territory (UT) covering some 135.84 million population. Double resistance was found to cover 542.7 million in the country. This mosquito was reported resistant to DDT from 261 districts in 13 States and a Union Territory (UT), involving a population of 702.09 million. Two other vectors *A. Stephensi* and *A. Annularis* were also known to have become resistant.[5] It is understood that the metabolic detoxification of the insecticide seems to be the main mechanism of resistance in the insects.

In the western pacific region the cause for concern centres around resistance amongst vectors of malaria, dengue haemorrhagic fever, Japanese encephalitis and filariasis although there are other vector borne diseases here as also in the South East Asia region. As is well known some 90 per cent of all the insecticide produced globally is used in agriculture. Cotton is estimated to use the largest share of this, ranging from 55 per cent in India for example and upto 90 per cent in some countries. Rice is yet another crop which uses a

large quantity. In general agricultural practices have been implicated in the development of resistance:

- development of resistance before use of pesticides for public health
- initial suppression of vector population by use in agricul tural operations
- increase in resistance coinciding with the use of agricul tural pesticides and
- development of cross resistance.

There is evidence of development of resistance in malaria vectors and Japanese encephalitis. There are similar reports involving black fly, onchocerciasis, in coffee trees and in body lice. Similarly there is a strong evidence of resistance caused through use of pesticides in public health operations.

Thus vector resistance as also resurgence problems have not only thrown the control programmes out of gear but also added to the costs thus pointing towards newer, safer alternatives for achieving some semblance of control over the vectors. It is for these reasons that increasing attention is now being paid to alternatives to pesticides, including use of biological control agents and plant products such as neem. Recently some new hope has been kindled around the development of a malaria vaccine against the causative agent, *Plasmodium falciparum* by a Colombian scientist in South America, Dr.Manual Patarrayo. If successful under field conditions, this should be relief to somewhere between 300-500 millions around the globe who are afflicted with malaria, of which estimated one and a half million to 3 million die every year.[6]

Dealing with Pesticide Poisonings

It seems clear that a very large number of pesticide poisonings and deaths go unreported in the developing countries and of these India may be a leading one. This is clear from the very low levels of reporting and almost clear absence of a suitable infrastructure. Time and again it has been found that pesticide poisoning is taking a heavy toll on account of the absence of a speedy communication system as also absence of correct diagnosis and treatment for the victims. In fact in vast majority of our health centres and even hospitals there is not even a semblance of a system or trained staff to deal with emergency

cases of poisoning from pesticides, by way of first aid, including information on antidotes and their easy availability. This is borne out by the fact that the ICMR way back in 1971, brought out a bulletin on the subject and it is not clear whether this been updated since. This means there is total absence of accurate and substantial information by way of literature on the subject and the only source of information would be reliance on the word of the manufacturer, hoping that the container with the pamphlet is made available by the patient or his wards. In any case quite often the pesticide is purchased and available in loose form from large sized containers or bags. This apart quite often the practitioners or the paramedical staff are not well versed in the subject.

It was in this background that UNDP-WHO-SEARO joined hands with the All India Institute of Medical Science, New Delhi (AIIMS) to organise in 1991 a Workshop at New Delhi on the 'Establishment and Stregthening of Poisons Control Centres in India'. A glance at the proceedings brought out in 1993 shows that in USA, perhaps the first Poison Control Centre anywhere was established in 1956, which followed a Report submitted by the Accident Prevention Committee.[7] This Committee had brought out that 50 per cent of accidents in USA amongst children involved some kind of a poisoning. In our country, however, the situation is almost pathetic and dismal, despite repeated and pointed questions raised on the subject over the last 7-8 years or more. For instance a question in the Lok Sabha raised by Dr Ravi Mallu on August 24, 1993 drew a rather indifferent response.[8] The Government informed the House that adequate provisions already exist for preventing deaths caused by pesticide poisoning in the country. The Government also stated that most of the States and the UTs had already notified staff for reporting pesticide poisoning cases under Section 26 of the Insecticide Act 1968. Thus the paper work for the sake of meeting the requirements of the law had been completed but on inquiry it will be found that in almost in all the States the work has been thrust on already over burdened administrative staff without any experience knowledge or understanding of the complexities of the problem. Elsewhere while dealing with this subject attention has been drawn to the fact that in several States even such an unsatisfactory arrangement has not been made so far. The Government also took the strange view that steps taken or proposed to be taken for educating the farmers

and the industrial workers includes proper labelling and leaflets provided with the pesticide containers. It was also stated that the manufacturers and/or their Associations perform these functions through the organisation of demonstrations etc., for safe and judicious use of pesticides. It is thus clear that this represents a total and serious lack of understanding of the subject of hazards that pesticides pose to the community. Because if the situation was as simple as thought by the Government there would have been no mishaps of any kind linked with the use of pesticides. The Government also closed its eyes to the mass of data available at each of the large Hospitals, particularly those attached to the Medical Colleges in the country, including the AIIMS in the Capital. At the above Workshop a number of recommendations were also made which reflect not only the dangers but also the concern and anxiety amongst the knowledgeable and motivated professionals of the medical fraternity dealing with poisonings frequently. At this Workshop three Groups were constituted to deal with the main three areas of concern, namely the Poisons Information Service, treatment of poisonings and lastly the prevention of poisoning. In all these important areas the clear consensus was the total inadequacy or even absence of available facilities and amenities or the infrastructure needed.[9]

Mercifully, WHO/IPCS (International Programme on Chemical Safety). once again helped organise an International Seminar along with the National Poisons Information Centre at AIIMS in November 1995 which was supported by the Council of Scientific & Industrial Research, New Delhi (CSIR), Indian National Science Academy and the Ministry of Environment , which also made a number of recommendations for streamlining the Poisons Control in the country.[10] More recently in November 1996 WHO-AIIMS organised yet another Training programme specially centred around the medical profession of Haryana State.

It appears that on account of a vigorous follow-up by the AIIMS management, the Government have eventually agreed to share one-third of the costs involved (a total of about Rs. 6 lakhs) for creation of and strengthening of the National Poisons Information Service. The AIIMs authorities are expecting to obtain the software for this computerised service which will be available on the Fax around the clock through out the country. How this one point service for the country without

sufficient backup works, remains to be seen and watched, considering the kind of communication services we have specially in the Capital apart from other constraints and handicaps. One would hope that the AIIMS have taken into consideration the high cost of communicating on the modern, speedier methods of communication for information to be provided to the needy and made adequate provisions for the purpose.

Welcome as this beginning no doubt is, it represents only a proverbial drop in the ocean and constitutes a typical bureaucratic action to ward off any hard decisions and to divert attention and heat which has been generated over the past 7-8 years both in the Press and the Parliament on the subject. Public awareness has been created particularly after the Bhopal accident and the incident at Basti in UP which received considerable media coverage and later figured in the Parliament. Apart from this a number of national and international Seminars/Workshops etc., have been held in the country–some 15 of these atleast during the last 3-4 years which have helped to keep the matter in the public eye as also drawn attention of the policy and decision makers. Unfortunately the response and the corrective action taken has been miniscule and tardy.

A reference has already been made to the ICMR Manual on treatment of pesticide poisonings prepared way back in 1971. This cannot be expected to deal either with the new pesticides registered and in wide use since then, nor can this be expected to include and cover any newer information on treatment as also antidotes. Thus the experience gained in the country and elsewhere on the subject remains unutilised in the treatment of such new cases of poisoning.

This apart there are over 300 Primary Health Centres(PHCs) in the country, one for every 30,000 population , which is staffed with a Medical Officer, one Block extension educator and other supporting staff. At present three PHCs are attached to each of the 106 Medical Colleges in the country. However, from the presentations made at the AIIMS Workshop, it is apparent that there were serious shortfalls in the availability of antidotes and other drugs needed for treatment and analysis work. In fact basic equipment and essential drugs were generally not available. Further the Medical Officers need to be adequately trained for specialised

needs for gastric lavage and peritoneal dialysis etc., all of which points towards essential and urgent need for training and refresher courses. It also was pointed out that there was a pressing need for a site laboratory for routine urine and blood analysis. For instance use of activated charcoal which is a common treatment, has been found to be ineffective in the case of malathion, DDT and N-methyl carbamate. Such a situation obviously calls for a broad based training programme, a notification system, information service, easy contacts and communication and interaction between various groups involved apart from strengthening of the amenities and infrastructure to make these services effective and meaningful. There is no half way house when it is battle between life and death.

We have dealt with the problems of poisonings in relation to resistance and resurgence particularly arising from pesticide use in agriculture and public health in the context of the rural scenario which by and large remains neglected as the traditional backyard. A look at the urban scene in respect of vector and pest control appears to be no more cheerful.[11] As it is the global urbanisation trends are ominous. While in Asia some 26.4 per cent in 1975 lived in urban areas, the estimates for the year 2000 are 38.1 per cent. The world averages against these are 39.3 per cent and 49.6 per cent respectively. In 1950 in Asia 16 per cent lived in urban areas as against world average of 28.6 per cent. These estimates are based on the world population estimates of 2501.2 millions in 1950, 3967.0 in 1975 and 6253.1 in 2000.

One can therefore well visualise the formidable tasks and challenges facing future generations which has led to the present day strong movement towards sustainable development. In our context, part of this situation has been created by the widespread and uncontrolled use of pesticides which are no longer the magician's trump card. This situation has been further compounded in the urban centres teeming with human dwellings with a poor system of sanitation and a total absence of planning aggravated by overcrowding and inadequacy of designs for houses. This is further accentuated by easy shortcuts in view of inadequate resources. This is particularly true of the situation generally in the third world although it is equally true , perhaps to a lesser extent for the deprived poor anywhere, including in the affluent world.

It seems clear that the continued use of the chemicals for pest control including the vectors, is now fraught with dangers. However, the Governments in general are both unable and unwilling to provide the large funds needed for embarking upon a satisfactory long term environmental management programmes. Of course, this does provide critics a handle to claim the unhidden role of the vested interests represented by manufacturers and the vast and powerful distribution and marketing channels not to forget the media which all seem to be content with profits from poisons.

While there is a wide range and variety of chemical control methods the residual application, space spraying, larviciding, repellents, mosquito coils, mats and canister sprays, all suffer from many disadvantages as has been brought out earlier. In view of these weighty considerations there has been increasing attention world wide to seek alternatives and considerable study and attention has been given to the use of traditional and indigenous as also natural, biological pest control agents which include bacteria, viruses, fungi, nematodes, larvivorous fish as also cats and dogs.

These are a part of the urban vector control plans in order to achieve environmental protection for over 3,000 millions encompassing 24 cities in the world with a population of over 10 millions each. These cities hardly have any matching public services, heightened further by social inequalities. Health problems associated with transmissible diseases may thus be the order of the day and may flare up as in case of the recent plague outbreak in the western part of India or the recent dengue epidemic which throttled life and normal activity in the Capital and the surrounding areas with resulting severe socio-economic repercussions. It therefore seems imperative that we shed our dark glasses and look afresh at the challenges facing us globally and work feverishly towards finding, down-to-earth, pragmatic alternative sustainable solutions and answers even if this means digging deep in yester years indigenous, traditional experience and knowledge which we have discarded or lost but which seems to have survived in some points and places for a variety of reasons.

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Chapter - 6

Advertising and the FAO Code on Pesticides

An attempt has been made to assess the usefulness along with the attendant risks from pesticides. The evidence and experience seems to be overwhelmingly united , earlier the better, on the desirability of eliminating use of these highly toxic products which have turned out to be totally environmentally unfriendly and unacceptable. This is despite the early advantages these offered leading to high expectations. In the light of this some of the well informed public spirited groups and individuals have been suggesting that the sale of these agrochemicals may be suitably controlled, in order to restrict their widespread, ill informed and ill advised use. This suggestion has its basis in the generally ill-informed, illiterate and untrained farmers and applicators specially in the third world countries where the applications are often done with bare hands and without the aid of machines or proper sprayers etc., and without any protective clothing and protection gear. It has been suggested that pesticides may be sold only against a prescription as is the case with several drugs, in this case to be authorised by suitably designated agriculture authorities. This suggestion would not be considered unreasonable or far fetched when it is considered against the background that despite the knowledge of their inefficacy in several situations, the not so well off and poorly informed farmers continue to prefer the use of cheaper pesticides like DDT, BHC, etc. In some cases there has been a total failure of crops despite heavy use of pesticides as in the case of cotton. In fact such situations resulting in serious economic crisis there have been reports of farmers committing suicides in the state of Andhra Pradesh and elsewhere. Further in many cases poverty leads people to undertake use of pesticides, despite their knowledge of the risks involved. Thus there is a strong need for educating the farmers/workers/applicators and those

exposed, by all possible means at our command. Selling pesticides against prescription would help in ensuring that the correct information on the recommended chemical and dosage etc., could also be conveyed to the user, who now almost universally rely upon the advice and suggestion of the pesticide seller , or manufacturers field representatives, whose outlets are strategically located in almost every place near the vegetable and fruit markets where the farmers visit very frequently to sell their produce.

In this background calls have been made by the voluntary groups and other like-minded individuals to the authorities, suggesting suitable curbs so that the sales could possibly be restrained instead of promoting use through advertisements on the media in order to lure the unwary. This suggestion would also apply to many other modern day advertising gimmicks including gift schemes etc. which are aimed at vulnerable groups.[1]

It was in recognition of such dangers that the FAO in 1986 adopted a Code of Conduct on the Distribution and Use of Pesticides to which a large number of countries are now a party. This Code, amongst other items incorporates Article 11, devoting entirely and specifically to advertising. A quick perusal of the mass of advertisements both in India and elsewhere as also other promotional literature and handouts would leave no doubt that the principles underlying the Code are observed more in breach than in faithful observation of its clear directions. Take for instance the advertisement for chlorpyrifos (Dursban) at the NOCIL plant located in Lote in Mahrashtra. Incidentally this Factory was recently involved in an accident with their new chlorpyrifos plant resulting in three deaths and 25 injured in a happening which received no media attention in this country although it was reported overseas by vigilant NGOs through an announcement in the Agrow Trade Bulletin.[2]

The accident resulted in the release of acrylonitrile gases. A reference has been earlier, in passing, of the virtual ban on the screening of a video, *the Killing Fields*, produced in 1990 through an NGO with a grant from the Ministry of Science and Technology, which focused on the alternatives to pesticides in the tropical countries after presenting the seamy side of these chemicals. It is a pity that even after nearly five years, the Information and Broadcasting Ministry, which has

a virtual control over the TV in the country, has not found time for screening this Government funded half-an-hour video which has won laurels and high appreciation wherever it has been shown within and outside the country. In fact the video has been in great demand and is being used by many NGOs and some training and teaching Institutions all over the country and else where. The power and influence of the chemicals manufacturing lobby and the powerful vested interests is also reflected generally in marketing and advertising, specially on the TV in as aggressive a manner as they please. This is largely because of the fact that while the Indian Government is officially, on paper , committed to the FAO Code, in practice it is clear that there is no intention of enforcing any of the provisions of the Code. This is in line with provision of law for enforcing the reporting of pesticides poisonings, which seems to be no concern of those who are charged with this responsibility.

All this seems to boil down to the reality that the Government is more concerned about promoting exports of pesticides in order to earn desperately needed foreign exchange which incidentally is a high priority as the Government have commitments to repay the huge foreign debts loans and interest thereon. The Government has also been keen on promoting the sales of agrochemicals within the country, for which considerable subsidies have been earmarked in the mistaken belief that without the use of pesticides the country will not be able to sustain its production, a belief which has got ingrained, irrespective of a mass of data and experience world wide.

This is also abundantly clear from the Government statement in the Rajya Sabha made on 27 March 1992 in reply to a question by Mr B K Hari Prasad ,on mosquito repellents. Shri Prasad wanted to know, *inter alia*, "whether the Government propose to stop imports and advertisements of all pesticides such as "HIT" on Door Darshan. Without batting an eyelid the concerned Minister informed the Parliament that," It was not possible to stop advertisements of pesticides..... registered by a firm, through any media as long as these are registered under the Insecticides Act 1968".[3]

In other words even though some of these pesticides are under a serious question and a cloud, under review by the Government itself which may well end their registration or

attract other curbs, the sellers are free to not only market but also actively promote these poisons, some of which may be already under a ban in other countries. In fact until recently there were restrictions and curbs on advertisements including surrogate advertisements, of tobacco and tobacco products in the print media and alcoholic drinks on both print and TV media. Similar curbs have recently been imposed on advertisements both on print and TV media in respect of baby foods, but all of a sudden it is not uncommon to see the advertisements all over the popular commercial news media although not yet on the Government run TV. One could draw the conclusion that this is the aftermath of the new and recent liberalisation and globalisation policies of the Government which seems to have brought about a change , unwritten , in the implementation of the earlier clear Government policies on the subject. So it should be no surprise that the chemical pesticides, one of the worlds acknowledged , powerful poisons, continue to be promoted through advertisements notwithstanding illiteracy of end users and consumers and the serious health hazards.

It is correct however that the situation in India is neither surprising nor unique as the MNCs are following more or less similar practices elsewhere except where there is strong public opinion supported by law. The Indian counterparts in manufacture and marketing are generally working hand in hand (or glove) with the MNCs ignoring observation of the Code or Guidelines on the subject notwithstanding either the International Chamber of Commerce (ICC) Code of Practice or their Indian counterpart, the Advertising Standards Council of India, which has recently been severely mauled and described as biased, ineffective and practising double standards and worse.[4] The ICC Code of Practice clearly expects that all advertising should be legal, decent, honest and truthful. It requires further that every advertisement should be prepared with a due sense of social responsibility. The ICC Code goes on to recognise that small print in advertisements cannot provide for escape from the obligation of judging from their likely impact on the consumer who carries a lasting impression from a brief scanning of the advertisement. The ICC Code also calls upon the advertisers not to abuse the trust of the consumer or exploit their lack of knowledge or experience.

The ICC Code lays down special provisions for advertising dangerous products and says the advertisements for

products which are potentially poisonous, inflammable or otherwise dangerous but which may not be easily recognised as such by the consumers should indicate the potential danger of such products. In Malaysia which has been active and alert in the area of pesticides, the Malaysian Pesticides Board has laid down strict rules covering pesticide promotion. In any case apart from the general apathy of the Government in such situations, the matter in India has been further aggravated by the entry of the private out of the country Satellite TV, in our case the powerful STAR TV which can now be found almost in every home. This has in fact resulted in bidding goodbye to any Codes or Guidelines whether national, international or governmental. Sometime during 1993 for instance there was an aggressive, persistent and a rather effective advertising programme launched on the Star TV estimated to be viewed by 200 millions in India alone apart from a large viewership in Middle East and Asia Pacific. This programme was woven around a rather charming, attractive well dressed, affluent woman (every ones dream and fantasy no doubt) in her equally beautiful home, going around spraying the fragrant pesticide aerosol can in hand without any caution or care for the results. In fact this campaign was followed by a free distribution of a small can against production of a coupon in the front-line high circulation national dailies. Although we have no details, but looking at the presence of that brand all over the city shops, there is no doubt that the campaign was successful in pushing sales and also letting people know and believe that the fragrant, camouflaged pesticides, though lethal and toxic, present no problems and can be used for spraying in closed homes dressed in full regalia , without a second thought. Considering that such advertisements are made by the Indian based firms whether put out in India or abroad are paid for from India, there is no doubt that the Government could impose any restrictions , including action for defiance against the Insecticides Act or the FAO Code or other plethora of laws at the command of the Government. But this requires political will and the infrastructure, both governmental and non governmental and possibly *suo moto* public interest petitions to the Courts, an avenue which of late has been proving highly successful.

One of the more aggressive campaigns has been well described and illustrated with production of the posters and

door mountings.[5] This draws the conclusion that even 8 years after the FAO Code was introduced, the Industry continues to blatantly violate the Code both in letter and spirit. The writer cites an example of an advertisement, on Paraquat and Nature, working together in perfect harmony, by a multinational corporation (MNC) in Malaysia which appeared in the popular *Malay Mail*. Fortunately the advertisement was withdrawn soon as a result of Government action. The author has also given details of a Thiodan (Endosulfan) advertisement in Guatemala, painted on a door in a village showing a picture of a happy smiling butterfly, once again in clear violation of the FAO Code. Yet another advertisement of Fusilade in Guatemala shows a young attractive woman wearing a grass skirt on one side and minus the grass on the other side, thanking Fusilade for the loss of grass weeds and baring her beautiful body. While some of the NGOs attached to PAN have been active in monitoring such blatant advertisements exploiting human weaknesses specially that of gender, by and large these go unchallenged and at what considerable public cost is any ones guess.

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Chapter -7
Sustainable Development

Sustainable agriculture has now become a common global phrase having roots in what we have inherited from the Earth and what has survived through the ages from human beings quest for knowledge through the innate spirit of reaching at the truth through trial and error by learning from our failures and successes - what we ourselves hope and wish to pass on to the future generations.

However, it does seem that we have sadly erred in some of these assumptions which is now forcing us to retreat and re-examine where we have gone astray. This seems to be necessitating not only a minor surgery or treatment but a major effort which seems to be taking us back and possibly force us to re-adopt what had been discarded. This of course is a reference to our adoption of technologies associated with the use of agrochemicals in agriculture. More about this later but let us first look at the massive thinking that has been generated around the concept of sustainable development which encompasses all developmental activity including agriculture, the subject matter of this treatise.[1,2,3,4]

The credit for the push to the emergence of the concept of sustainable development may perhaps be given to the World Commission on Environment and Development (WCED), which is now generally acknowledged to be an epoch making event, creating a global agenda for a change of directions in the realm of poverty, economic growth, industrialisation and more importantly on environmental degradation. It was in December 1983 that the United Nations (UN) General Assembly at its 38th session asked the WCED to: Define shared perceptions of long-term environmental and development challenges, and the most effective methods to respond to them; Recommend means to foster greater co-operation among

developed and developing countries, and to attain mutually supportive objectives taking account of the relationships among people, resources, environment, and development; and Propose long-term strategies to achieve sustainable development, combining global economic and social progress with respect for natural systems and environmental quality.

The WCED was created as an independent body in December 1983 following the above Resolution. Gro Harlem Brundtland, former Prime Minister of Norway, was appointed as the Chairperson and Dr Mansur Khalid, a former Foreign Minister of Sudan as the Vice Chairperson and together with the UN Secretary General, the members of the WCED were appointed. The Commission began its work in Geneva in October 1994 followed by deliberative meetings, including open public hearings which were held in 16 major cities around the world.[5]

The WCED was assisted in its work by a group of experts, special advisors and advisory panels. The WCED also commissioned 75 studies and reports relating to the key issues it was handling. The Commission prepared its report in 47 volumes which was released in London in April 1987. Aptly called *Our Common Future*, it was presented in October 1987 at a special session of the UN General Assembly which adopted a Resolution establishing a broad follow-up procedure on it. Between April and October 1987, the Report with its recommendations was also presented to policy-and decision-makers in over 100 countries, including the NGOs and the Press with a view to generate interest. With these inputs, *Our Common Future* is considered to have achieved high public and political attention, thereby creating the right environment for a global effort to initiate and achieve the objectives of sustainable development. This Report is based on the conviction that the environment and economic development are inter twined and that development cannot be at the expense of the environmental resource base. Further it cannot be undertaken at the cost of environmental destruction. For instance deforestation destroys not only natural habitats but increases runoff, accelerating soil erosion and consequent siltation of rivers and lakes, seas etc. Likewise rapid population growth has a profound effect on the environment and in many situation arises from inferior status of women. Similarly an impact on ecology transcends

political boundaries of the globe or the States in the same country take for instance water pollution, chemical runoffs from farms, hazardous emissions from factories, to cite a few examples. Sustainable development thus requires changes in policies both domestic and international. Sustainable development is also intended to meet the present needs without affecting the needs of the future generations. According to this treatise, sustainable development is made up of two key components: the concept of needs specially the essential needs of th world's poor and the limitations created by technology and society on the ability of the environment to meet these demands.

Such a development seeks to meet the basic needs of all-ensuring that population growth remains in harmony with Earth's natural supply systems. In a nutshell such a developmental system may well be envisioned as a process of developmental change whereby the use of resources, investments, technological development and institutional change, all move towards meeting human needs of both today and the future. *Our Common Future* also points out that the malnutrition of 730 millions of the world rendered them without much stamina for leading productive lives, thereby serving as a serious brake on national growth. The Report also analyses the environmental consequences of a heavily subsidised system which in many situations in the industrialised countries has resulted in:

- Lower productivity
- Destruction of countryside and a setback to the cultivation of marginal Lands and watershed protection areas; and ground water pollution on account of heavy subsidies on agrochemicals.
- Sustainable development is also considered to protect the natural resources which lie at the centre of development process.

In respect of sustainable agriculture this means ensuring that the soil, water and forests are not in any way degraded. The present trends of soil erosion even in affluent countries like the USA and Canada are forbidding. Soil erosion not only makes it more difficult for the root crops to take hold, denude the land and turn soil less able to hold water but also leads to silting of ports etc. and also adds to the severity of

floods. There is also the added danger of water logging, salinisation and alkalisation. Thus soil degradation erodes the overall resource base of agriculture and therefore the Report stresses on water management. The impact of agrochemicals on health, soils and environment has been discussed at some length earlier in this publication.

The Report also brings out that the organic nutrients can *partially* (emphasis added) replace chemical fertilisers with no loss in production and calls upon Governments to encourage such practice. However, as we will see later, there is sufficient evidence from several controlled case studies world wide which go to show conclusively that it is possible not only to partly replace the chemical fertiliser but also to get higher yields without their use. Likewise it is now established that effective pest control can be achieved minus the use of the chemical pesticides without any resulting fall in production.

Understandably the Report also dwells on the need for protection of forests and their controlled use as also the need for checking advance of deserts. Our Common Future also emphasises need for promotion of fisheries and aquaculture in order to ensure a major and an important source of nutrition and livelihood which in fact is what the philosophy of sustainable development is all about.

To produce sufficient food it would be necessary to utilise natural resources in a close combination with technological, human, agricultural and energy inputs in order to make this concept into a reality. There is also a need for relevant land reforms which alone will encourage people not to violate ecological imperatives for feeding themselves,

For the same reasons, traditional rights of subsistence farmers, pastoralists and nomads have to be respected and restored where necessary so that the resource base is not threatened by them. Alongwith land reforms, small farm holders must be provided access to scarce resources and credit and services apart from a voice in formulating agricultural policies to ensure integrated rural development. Efforts have also to be put in to ensure equitable food distribution and to ensure a reliable and a dependable system of food security as also concept of equitable sharing. The Report amongst other relevant subjects such as energy, also touches on the need for the preservation of genetic materials and resources not only of wild species but of varieties within a species the absence

of which would deny us the potential benefits of a wider genetic resource base .

There is no doubt that the Report drew world attention to the deteriorating situation *vis-à-vis* environment, energy, population and human resources, food production and all the related socio-economic-political factors, including the need for management of the Commons. The awareness created all round no doubt culminated at the historic UNCED and the Global Forum and the Rio Declaration adopted at the Earth Summit in the month of June 1992 in Brazil.[6]

The official agreements were the Rio Declaration on Environment and Development; Agenda 21, including the agreements on the means of implementation; the Declaration of Principles on Forests; the Framework Convention on climate change and the Convention on Biological diversity.

Agenda 21 is considered to be the centrepiece of the Agreements reached at Rio, covering a very broadbased action programme embracing development and environment in an integrated manner. One positive and material outcome was the creation of a Commission on Sustainable Development (CSD) which has had two meetings so far, both in New York -- first in June 1993 and the second in May 1994. It may be of interest to mention here that the UNCED decisions and creation of the CSD in so far as agriculture is concerned had its base in the Den Bosch Declaration on Sustainable Agriculture and Rural Development (SARD). The Declaration had emerged at the FAO-Netherlands Govt. Conference on Agriculture at Hertogenbosch, Netherlands, 15-19 April 1991.[7,8,9]

These high level exchanges involving over 100 countries continue at the official levels with an increasingly active involvement of the NGOs. However, as per records the pioneering and concrete effort towards this new doctrine of Alternative Agriculture-- a movement aimed towards the complete elimination of agrochemicals was in fact initiated in USA by the National Research Council in 1984. This was almost at the same time as the WCED, leading to what by any standard would be termed as a pioneering if not historical Report, the Alternative Agriculture Report in 1989, assembled with the effort and the inputs of the top people in their respective professions.

In India there has been an almost total absence of any

interest and concern in this area from the official side which includes not only the bureaucratic Government set-up controlled and run by the all-knowing administrators but also by the ICAR and its huge network of R&D Institutes . There has been a similar silence on the part of 30 odd State Agricultural Universities in the country until rather recently when with the initiative and financial support of Department of Biotechnology and not the ICAR or the nodal Department of Agricultural Research and Education, a few projects have been initiated for the past 3-4 years. However, there are two Centres–one at the Tamil Nadu Agricultural University, Coimbatore and the ICAR's Biological Control Centre, Bangalore, both of which have been working for quite some years for developing biological control agents. Incidentally the ICAR's above unit at Bangalore which was the earlier Commonwealth Biological Centre.

However, in 1987 as a part of the application of science to consumer protection, the Department of Science and Technology, in a Status Report made a reference to the need for the adoption of the Ottawa Declaration of June 1986. This Declaration had pleaded for development of agricultural systems fundamentally different from those that were being generally promoted at the time.[10,11] The thrust of this document was in fact for finding safer alternatives to the use of pesticides both in agriculture and public health, These suggestions and recommendations were later re-echoed, a lot more forcefully at a DST supported Seminar—the National Core Group Meeting on Pesticides: Problems and Alternatives in its Recommendations (1989).[12,13] The clear consensus at the meeting was fully supportive of the DST Report of 1987 and strongly supported the Ottawa Declaration as also the concept of IPM all in the quest for finding alternatives to pesticides. This was followed by a National Seminar organised at the Udaipur University in 1991 on Natural Farming.[14] The recommendations arising from this Seminar strongly supported the adoption of a new approach towards farming--a systematic, scientific study and switch over to the ecological farming without the use of any agrochemicals, fully endorsing the recommendations arising from the three earlier meetings.

The culmination of the NGO effort was the organisation in 1992 of a National Seminar on Sustainable Agricultural Development organised at Pondichery, coincidentally one of the pioneering field Centre for ecological farming. The Recom-

mendations made at the Seminar fully supported the ones made at the three preceding seminars referred to above. While doing this the Seminar also called for a concrete time bound Action Plan towards achieving the goals of sustainable farming systems for the country.[15]

In this background, full credit needs to be given to the Department of Biotechnology, which despite heavy odds, took up in 1989 a programme of some 25 projects in the country all aimed at finding workable alternatives to the use of agrochemicals, a task which should ordinarily have been the responsibility of the ICAR/Ministry of Agriculture.

It is both difficult and hazardous to say where the concept of sustainable development may have originated but this seems to have developed and emerged from thinking, experience and the work of individuals and groups around the world--some even without attracting direct notice and attention. Further many groups, including individuals have been practising ecological farming, despite lower yields, believing strongly that this was a better way of food production and farming. In fact in countries such as India, in the case of small and marginal farmers working in dryland areas, high cost of inputs needed would be far too high and unaffordable given their economic situation.

There have also been strong religious groups, such as Amish and Mennonite farmers in the midwest and Pennsylvania in the USA who have been practising ecological farming or as is the case at Auroville, Pondichery or possibly Gandhiji's Farm at Sewagram in Maharashtra. The Rodale Institute in USA have likewise been promoting alternative agriculture for a considerable period. In addition to this over the decades there have been other pioneering movements, such as Natural farming in Japan , Biodynamic in Germany, Permaculture in Australia, all variations on the theme, with many strong followers and groups practising these principles around the world including India. A reference has already been made to one of the earlier scientific statement on record from the scientists who met at Ottawa in 1986 on the World Environment Day, pledging themselves to the promotion of sustainable agriculture, including crops and animals. Yet another strong effort in this direction was the publication, *Fighting Pests the Natural Way*, brought out by the Pesticide Action Network, Europe in 1988, which dealt with many of these issues and concerns.

Another useful input to the sustainable agricultural and rural development (SARD) programme aimed at putting into practice the guiding principles outlined in Chapter 14 of the Agenda 21 is the Report of the Conference on SARD held at Stoneleigh, Warwickshire, 3-4 Sept. 1993. The 60 participants were drawn from farmers, farmer organisations and the NGOs from U.K. with inputs from the concerned people from Australia, Dominica, Eire, France, India, Palestine, Togo, Uruguay and Zimbabwe.

The working definition of SARD at this Conference based on the earlier FAO Council's (1988) and expressed in Agenda 21 was: The management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable.

This SARD Conference touched on relationships between the developed and the developing countries, the impact of GATT and CAP and emphasised and supported Chapter 14 in respect of food security and food for local needs coming first in our planning and thinking. An outline of a Proposal was framed touching on some of the essential issues.[16]

There have been many other pioneering and solid contributions the world over to help launch the concept of what has come to be known as Alternative Agriculture, which in effect attempts to find viable alternatives to the present chemicals based agriculture that has come to be referred to as conventional agriculture. Some of these initiatives based on a scientific approach and a technical back up, including R & D and controlled trials could be attributed to the Rodale Institute, Kutztown, Pennsylvania, USA, the Land Institute, Salina, Kansas, the Universities of Kansas (Manhattan), California (Santa Cruz and Davis) and several other Universities like Iowa, Oregon, in USA, International Centre for Tropical Agriculture (CIAT) in Cali, Colombia amongst many others .Naming the above reflects only the limited information available with the writer which fits in with the overall scope and thrust of this publication as also limitation of space rather than any thing

else. In addition there has been a movement in this direction at the International Rice Research Institute, Manila and the FAO projects working in Asia Pacific, Information Centre for Low-External Input and Sustainable Agriculture'(ILIEA) and ETC-Foundation in Holland, the Natural Resources Institute in UK. This apart several institutions and NGOs in various countries as also individuals have been promoting and practicing ecological farming, who have been cited throughout the text of this publication. As already stated the above list is by no stretch of imagination complete in any manner and an attempt will be made now to refer to some examples particularly which have achieved some success or hold promise for the future.

First of all an attempt will be made to examine and review the pioneering and painstaking 5 year work with manifold and myriad inputs on scientific and systematic basis undertaken by the Board of Agriculture under the aegis of the National Research Council (NRC), Washington, which has been brought out in the form of a Report, the Alternative Agriculture report (1989).[17] The Report gives the background to the work of the Committee, which was created to meet the problems faced by US Agriculture in the early eighties. These problems were no ordinary happenings as these had disrupted the financial viability of many farms actually leading to bankruptcy, shattering the farm economy. These farms like the other prevalent ones were based almost totally on the chemical system which has come to be known as conventional farming. The report also points out that in the thirties the crop yields in USA, UK, India and Argentina were essentially the same. However, with the adoption of technologies of chemical inputs, high yielding varieties (HYV) seeds, the yields rose dramatically in the major commodities-- particularly, wheat , rice and maize. However, this success and adoption of new technologies also brought in a chain over the years of many new imponderables necessitating a close look at what went wrong . The US authorities apart from the resulting high costs of agriculture were even more concerned about agriculture turning out to be the single largest non- point source of contamination of water, soil erosion, pesticide resistance and pesticide residues.

In USA, production, processing and sale of food and fibre in 1987 formed 17.5 per cent of the Gross National Product (GNP)-- about US$ 700 billions although agriculture alone

formed 2 per cent of the GNP. Exports of agricultural commodities in 1981 was US$ 43.3 billions which fell to about 32.1 billions in 1987. All this resulted in a serious setback to the traditional export market of USA. It was also observed that many farmers in the USA were instinctively beginning to reject conventional farming involving high level use of agrochemicals and adopting methods aimed at reducing costs of inputs. It was in this background, in order to examine and understand the alternative methods adopted by these innovative farmers that this Committee decided to have a close look--aimed at finding the answers on a sound, scientific footing.

In this search the Committee also set about to describe and define the widely emerging term, the alternative agriculture (AA) which is reproduced below. As we shall see later, many others including the FAO had also attempted to create a framework and defining and describing the term sustainable agriculture (SA). Although the terms and emphasis may seem to vary but on close examination it will be seen that there is a close and intimate common denominator in these definitions apart from a commonness of purpose and intent.[18]

NRC Definition of Alternative Agriculture(AA)

AA is any system of food or fibre production that systematically pursues the following goals:

- More thorough incorporation of natural processes such as nutrient cycles, nitrogen fixation, and pest-predator relationships into the agricultural production process;
- Reduction in the use of off farm inputs with the greatest potential to harm the health of farmers and consumers;
- Greater productive use of the biological and generic potential of plant and animal species;
- Improvement of the match between cropping patterns and the productive potential and physical limitations of agricultural lands to ensure long term sustainability of current production levels; and
- Profitable and efficient production with emphasis on improved management and conservation of soil, water, energy, and biological resources.

The study also revealed that various parameters and principles formed the basis for AA. These included crop

rotation which helps the control of weeds, disease, insects and other pest problems and increase in available soil nitrogen. This apart there was reduced need for chemical fertiliser. Further if conservation tillage practices were adopted, there was a gain of reduced soil erosion.

Likewise IPM reduced the use of pesticides through crop rotations, scouting, weather monitoring , use of resistant cultures, time of planting and biological control. Control of weeds was also possible and most importantly the resulting improved plant health helped crops resist better insect pest attack and disease. Alternative agriculture also emphasised tillage which conserved soil and water. Similarly the adoption of animal production systems that result in disease prevention thereby reducing the need for use of antibiotics. Genetic improvement of crops is also encouraged in order to resist insect pests and diseases and to help effective use of nutrients.

The report covers the results of assessment of the present conventional and alternative farming practices in USA in order to see the potential influence of AA on economic, environmental and public health goals. The report also has analysed the factors including Govt. programmes and policies that influence the switch over to AA. Another important component of this report was a review of AA in order to see what further R&D was needed. The Committee reached some important conclusions indicating that the wider adoption of proven AA systems would lead to higher economic benefits to farmers and even more importantly environmental benefits for the country. Generally speaking the existing federal policies were working against environment and crop rotation, certain soil conservation practices, apart from pesticide use reduction and resulting switch over to biological and cultural methods of pest control. The report highlights the need for a systems approach especially in view of wide regional differences. The report however acknowledges that innovative farmers had on their own steam evolved many AA farming methods and systems which met specific local needs. However, these needed to the buttressed and helped for an effective adoption.

The committee noted that apart from economic hardships, conventional farming was leading to environmental imbalances and public health problems. That apart there was

the dangerous situation of the development of resistance to pesticides amongst insects, weeds and pathogens. Insects and pathogens were continuing to overcome the inbred genetic resistance of plants. Nutrients from fertilisers and animal manures and pesticides were finding their way to water resources including surface and ground water and making agriculture a major non-point source of pollution. Yet another problem was that of decreasing genetic diversity of many crops and livestock species.

Decrease in genetic diversity both in major crops and livestock species particularly in case of poultry and dairy cattle, seemed to offer a potential threat for any sudden wide-spread economic losses from disease, threatening both economy and food security.

The report contains a set of case studies across the country in order to examine and evaluate AA to explore its future possibilities. Despite various difficulties, inherent in such a comparatively small sample size, many important conclusions have been arrived at.

The major conclusion reached, which also has relevance to our own situation, indicates that the farmers adopting AA despite several handicaps often have productive and profitable operations.

It also emerges that AA covers a wide range of technological and management decisions on farms engaged in reducing costs, on protection of health and environmental quality and enhancing beneficial ecological interactions and natural processes. In general it is felt that AA leads to reduced agrochemical inputs. Contradictory as it may seem AA requires more information, labour and time as also management skills than conventional farming.[19]

In the US set-up the federal policies have in effect discouraged or even penalised farmers who may have intended to adopt AA-- a situation which is no different from our own where the farmers in irrigated areas have benefited from supply of HYV seeds at low cost, subsidised agrochemicals, water and supply of energy. On the other hand such support programmes have also discouraged farmers from adopting intercropping or several other soil conservation systems--all technologies which are sustainable as against chemically based (conventional) farming which has led to the many ills now

facing agriculture including soil erosion, salinity, infertility, including human health and other ecological imbalances.

The government subsidies in USA as in India have tended to encourage the farmer not only to expand crop production on to marginal lands but also resulted in the production of crops in regions generally not well suited to a particular crop. Also US federal grading standards encourage cosmetic and insect-part criteria that have no relation to nutritional quality but encourages pesticide use at the expense of alternative pest control measures. Similarly the current US federal pesticide registration and regulatory measures are stricter than were in operation earlier on pesticides on the approved list. For instance it has taken decades before botanical pesticides or biological control agents were hesitatingly registered for use in India.

In the same manner in USA the thrust and quantum of R&D and extension work has been wanting in the area of AA, which includes inadequate funds and lack of a clear understanding of the pros and cons of conventional and AA systems. Whereas this situation is vastly changing in USA, in India to this date there is a total lack of understanding and awareness on the subject, unfortunately, not only amongst bureaucrats but also amongst our agricultural scientists. As we will see it is largely due to a few pioneering farmers and more recently a few NGOs and certain isolated cases amongst public sector units that the idea of AA seems to be creeping in largely on account of the strong trends and developments in the western world and increasing non-acceptance of conventional farm products by a sizeable section of consumers.

It is in this background and findings that the NRC on the basis of well-controlled 11 case studies have unequivocally come forward with entirely new directions of farming and moved towards the systems of alternative agriculture. The NRC therefore strongly recommends wider adoption of rotations in legumes and non-leguminous crops, use of improved cultivars, Integrated Pest Management and Biological Pest Control, use of disease resistant livestock, improved farm machinery, lower cost management which use fewer off-farm and synthetic agrochemical inputs apart from a host of alternative technologies and systems.

Apart from the above suggestions, a whole range of

policies and programmes have been recommended to protect land and water resources. The report also calls on the US Government to review the existing regulatory system of use of agrochemicals and to develop a new set of guidelines especially in respect of pesticides based on the review of benefits that accrue to consumers, growers and tax payers apart from the impact on public health and environment. One of the strongest recommendations pertains to the need for developing R&D to cover regional, multi-disciplinary, long-term research, demonstration and extension programme such as USDA's, low-cost sustainable agriculture (LISA) initiative, both for crops and livestock.

In the 11 case studies, an attempt has been made to focus attention and obtain authentic data on several practices which covers crop rotation that mitigate weeds, disease and insect problems apart from increasing available soil nitrogen and reduction in chemical fertiliser use, in conjuction with tillage, aimed at conservation and soil erosion control.

Use of IPM is aimed at reducing the use of pesticides through crop rotations, scouting, weather monitoring, use of resistant cultivars, timing of planting and through biological pest controls.

Stress has also been laid on development of management to improve plant health aimed at the creation of improved pest and disease resistance. Attention has also been given to use of soil conserving tillage, genetic improvement of crops for resisting pests and diseases in relation to better nutrient use. Likewise animal production systems to achieve preventive disease control, less reliance on high density confinement and reduced use of drugs such as antibiotics for therapy has been suggested.

Summary of findings of case studies have been presented in the tables in the above Alternative Agriculture Report which also give annual average temperature and precipitation in the area. Five of these are crop and livestock farms . The Spray Brothers farm near Mount Vernon, Ohio and the Breadahl farm near Fontentelle in South West Iowa and the Sabot Hill farm near Richmond, Virginia. In addition there is the Rodale Institutes' Kutztown farm in Eastern Pennsylvania and the Thompson farm in this category.

The Ferrari farm near Stockton, California and four

farms in South Florida, Stephen Parich and Sons and the Kitanina farm near Sacramento, California are essentially fruit and vegetable farms. Other farms include the Coleman Natural Beef near Saguache, Colorado and the Lundberg Family farms near Chico, California.

The results obtained in each of these 11 case studies are indicative and the numbers too small to warrant any far reaching conclusions. But it is clear from the report and summary of results in each case study that each of these, representing different types of AA technologies and practices was indeed a highly successful example of AA in its sphere with clear indication of being financially and commercially viable. It is in this background that the NRC have derived many recommendations and suggestions for future directions which have been discussed in the preceding pages.

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Chapter - 8
Basic Principles of Sustainable Agriculture

In promoting Alternative agriculture (AA) or Low Input Sustainable agriculture (LISA) or Sustainable Agriculture (SA), the US Department of Agriculture (USDA) emphasises that this is not a break with modern agriculture nor is it another name for organic farming. This system is also not for small farms or for livestock farms only and certainly this was not a step backward or even a panacea for all of our environmental problems. It was also not claimed to be a complete solution to the problems of farm profitability which were bugging US agriculture. In brief the program was designed to develop a full range of options for all farmers and did not intend to impose any limitations on any farmer. The four important elements of the crop farming system under the AA scheme were interwoven and interdependent and also intimately related to specific conditions of soils, climates and markets. These 4 main items were crop rotation, tilling practices, fertility and pest control.[1]

In USA for instance about three quarters of the country's crop was grown in continuous corn or in alternate years with soybeans, a mono or dual cultural practice made possible with the use of fertilizers and pesticides. Such a situation of continuous cropping posed several potential hazards to long range sustainability since these tended to interfere with natural processes. The repeated use of agrochemicals in continuous row crop farming for example has been found to suppress soil fertility as compared to the use of organic nitrogen sources such as legumes and manures. In addition there is a decrease in soil productivity, arising from compacted soil structure due to reduced ion exchange capacity as also reduced microbial activity. Such a situation also destroys the natural predators of crop pests, apart from increased erosion and leaching of chemicals into ground water. For these reasons, in AA, recourse

is taken to various crop rotations using oats, red clover, soybeans, corn, wheat/hairy vetch, oats/legumes mix, wheat/ soybeans hay etc. These crop rotation patterns are also termed relay cropping.

The prime purpose of rotation or relay cropping is to build up soil productivity and more importantly to interrupt the normal sequence in the lives of pests. AA also promotes ridge tillage which has been found to be a form of soil conservation with significant soil erosion control and weed control and overcomes other related problems faced in conventional farming.

The present day conventional farming continues to rely on minimum till or no till or mold board plowing, chemical fertilizers and pesticides as against AA, which relies on crop rotations, mechanical cultivation and innovative practices such as ridge till. Likewise AA uses legumes in rotation, greater use of organic nitrogen, less chemical N, P and K, and soil structure regeneration. Pest control is achieved through low input, biological controls, mechanical cultivation, crop-rotation, disease resistant cultivars, scouting for pests and use of chemical pesticides is made only as a last resort. In other words emphasis is on less total input and more on soil structure and pest cycle interruption.

In AA animal manure and green manure gradually replace chemical nitrogen which in turn helps in reducing denitrification, leach and volatilization and reduced use of Nitrogen by weeds. In these circumstances, the mineralisation rate is slow, matching long term crop needs. In this decay process there is production of humus which means conversion of plant residue into nutrients.

While nitrogen can be obtained through symbiotic fixation, phosphate and potassium are replenished through rock phosphates or animal manure and potassium through rock dust as against potassium chloride in conventional farming.

In AA weed and insect control methods are intimately related to crop rotation, the tillage practices and population dynamics of pests and their natural enemies. Pest control thus depends on interrupting weed and insect life cycles using rotation scheme, ridge tillage, allelopathy (emission of natural herbicides by plant tissue residues), as also mechanical

cultivation. The control of pests is also achieved through adjusting planting rate, time of planting, row and seed spacing and altering choice of crop or variety. Integrated pest management covers regular scouting and biocontrol through the use of other insects and pathogens to fight pests, biological pesticide formulations and an emphasis on the economic threshold of weeds instead of visual threshold. Crop rotation is considered to be a central element in any AA farming system and is the cornerstone of successful transition. This not only prevents buildup of pests and improves soil condition but also meets various other needs of farms, including protecting soil- water- climate resources, successful marketing of products, integration of livestock nutritional needs etc.

Under the 1985 Farm Bill, the US Govt. had a system of price support payments which stood withdrawn with the introduction of the 1990 Farm Bill following US-GAO report in the US Congress arising from National Research Council (NRC) report on AA. The latest AA research findings (upto 1980) under 100 AA projects involving 1860 farmers since 1988 is quite revealing and favourable for the adoption of AA. For instance these show that cover- crop practices cut soil erosion and reduce nutrient losses thereby protecting water quality and nutrients for subsequent crops. It also emerges that switching to rye or other allelopathic plants that are toxic to weeds often provide effective weed control. Likewise ridge tillage eliminated herbicide use in midwest trials. In the northeast disease free apples could be grown without fungicide use.[2] Similarly grazing sheep in orchards controlled weeds. Switch over to 3 year rotation boosted wheat yields sharply by breaking the cycle of disease organisms in the root zone.

Marine management systems reduced environmental problems while at the same time boosting profits. Intensive rotational regime was also found to reduce herbicide use and operating costs while improving year round forage management.

While the US farmers' experience and views continued to vary, it does seem that there is a wide-spread opinion in favour for the adoption of AA gradually, in order to reduce economic risks, which in effect means continued R&D work in AA and its application.

The concept and practice of SA or LISA received further

boost after many new facts and findings on sustainable agriculture R & D work were reported at a USDA Washington workshop on 3-4 April, 1990. These summarised the results of field R &D and new directions for SA as also a renewed commitment to it.

It was clear that SA offers choices to farmers which range from optional use of fertilizer, pesticides and other off- farm inputs in conjunction with the use of better management practices with the objective of minimizing such off-farm purchases. SA also puts an emphasis on crop rotation, integration of livestock and crop production as also mechanical or biological weed control. The main philosophy behind this was an Integrated Resource Management (IRM) an approach that looks at the farm as a whole. This in no way meant going back to low output of the 1930s or to manual low technical production. For that reason the term 'low input' appeared to be misleading as against SA which really means use of the best of technology in a balanced, well managed and environmentally sensible and responsible manner. This also relied on skilled management, scientific know-how, uniform resources as also a strong R & D backup.

The point to remember was cost-benefit equation, productivity and efficiency. All this meant a need for hard data for planning for the future, such as water quality, reduction of use of agrochemicals, IPM and Integrated nutrient management (INM) or IRM with environment and ecology in mind.

Apart from the active role played by the NRC, USDA has been pitching in considerable effort and resources in supporting the AA through the agricultural universities. Many of these in turn have been sponsoring well-planned experiments in the fields.

An example of this is at the Kansas State University, Manhattan report on the economic analysis of conventional and alternative cropping systems for Northeast Kansas.[3] Four alternative and four transitional cropping systems were compared to conventional agriculture on a representative northeast Kansas farm. The results showed that initially crop yields were the same in all cropping systems. However, the largest net return was from the wheat/clover-sorghum-soybean alternative cropping system. The conventional cropping system ranked only 6th amongst the 9 systems in net returns.

The conventional systems returns were lower by about 15 per cent thus showing the great potential of AA in NE Kansas.[3] The results clearly establish that the annual net return per acre from the alternative system [4], where no chemicals were used was higher than in respect of net income from a transition system-1, which used chemical inputs.

As in other situations, yield improvements may occur in AA due to a better soil moisture retention, soil fertility and possible allelopathic action. Studies in Nebraska and South Dakota have also yielded similar results although the profitability of these systems is sensitive to several factors including the types and length of rotation used.[4]

The idea of SA has penetrated the length and breadth of USA--not only amongst the policy and decision--makers represented by the USDA and the farmers but it has been ably and scientifically supported by the wide variety of R&D organisations and academics as also non-government organisations and trusts etc. This has taken the form of undertaking R&D, aimed at not only testing the known existing knowledge within the country but also drawing upon the experience of other countries. In addition considerable effort and resource has been expended in developing safer, alternative technologies, which may help move away from the chemical pesticide treadmill and the problems created therefrom.

An important part of this search in AA has also found its expression in the development of literature and records for the benefit of others in the form of reports, manuals, resource guides and other related forms of information for communication to the farmers etc., by the universities.

Take for instance the *Sustainable Agriculture Resource Guide* for Oregon and Washington. This 221-page document was funded by the USDA's Sustainable Agriculture Research and Education Program and the Northwest Area Foundation, St. Paul, Minnesota and prepared by the faculty of various agriculture departments of the Oregon State University, Corvallis, Orergon. The publication epitomises and illustrates the wide variety and range of skills and contributions that go into such publications to make such a Guide truly useful and meaningful for its target audience, in this case the farmers. It starts off with brief details of agricultural organisations in

the area and nationally with critical details of how to reach them and their areas of specialisation. In fact going through 5-page table of contents is itself a very rewarding experience.[5]

This illustrates how AA has become such a powerful movement in the USA and offers lessons for countries such as our own. Likewise there is information on resource material available, databases and computer software, including video tapes and other media offerings and the educational opportunities both national and international. The major thrust of the Guide is however on pest management and gives information and details of technologies available and how and where to procure these. Likewise there is information on soils, water resource management, on-farm experimentation and marketing. One table gives a list of weeds, the biological control agents and details of their distribution in the states of Oregon, Washington and Idaho as also periods of infestation and experience with control measures as also status of the availability. Yet another table gives an alphabetical list of biological agents and their mode of action. Details of commercially available selected microbial herbicides including some which are expected to be released have also been appended. The Guide describes briefly the first flame weeder developed and patented in the USA way back in 1856, a method now in use successfully not only in the USA but also in New Zealand and elsewhere for destroying weeds. Sources of supply this flame gadget have also been provided.

Similarly names of suppliers of non-living mulches both plastic and peat widely used and recommended as weed barriers have been included. There is also information on new mechanical bug vacuuming gadgets now in use for lettuce, grape and strawberries.

Guidelines have also been provided in tabular form for use of pheromone traps to monitor insect pests. The Guide also provided information on several microbial insecticides and baits containing a grass-hopper-parasite (*Nosema locustae*) and a formulation containing a beneficial nematode (*Steinernema carpocapsae*), to control immature stages of back line weevil and strawberry root weevil for use in cranberry fields.

Information has also been provided on some of the new improved microbial pesticides such as *Bacillus thuringiensis*(Bt). There are also suggested microbial varieties of Bt preparations for control of wax moth in beehives, larvae of gypsy moth and

spruce budworm for control of caterpillars/worms and larvae of mosquitoes, blackfly and fungus gnats. There are also brief details of Bt varieties for armyworms, colorado potato beetles, sod webworm in lawns and for cutworm and other lepidopterous larvae. For nematode management there is a very useful list of general books/periodicals, references. Soils also have received due attention through a range of book references.

There are useful guidelines on soil sampling, analysis and interpretation of results, along with a 5-page Table giving details of analytical laboratories for tissue, soil, water, feed, pesticides, heavy metals and counselling which serves the Pacific Northwest region of USA.

All in all this Guideline is a veritable goldmine for farmers which would encourage them to embark upon the SA path through supply of such difficult to obtain information on a platter. This publication illustrates what the extension is all about and how it works and attracts both attention, confidence and respect of end users. This is also an illustration of how the Universities operate in USA–as a strong arm for the transfer of technology, dishing out practical, down to earth knowledge without any window dressing.[6]

The University of California, Oakland, likewise has a Guide (1991) on similar lines stretched over 200-page priced low (US$12) to ensure this does not pose an impediment in acquisition (Sustainable Agriculture for California). This Guide has been prepared to provide answers to common questions on economic viability of SA and to provide in one volume widely scattered information. A multi-disciplinary effort, it covers 28 specific topics and covers subjects from cover crops, farm worker safety, aquaculture, to hunting and wildlife not to forget germplasm conservation.[6]

One of the early prophets of AA thinking in USA is credited to be Wes Jackson who has been promoting and practicing SA for the past two decades. In 1986 he founded the Land Institute on a 28- acre farm near Salina, Kansas and began seeking alternatives to till agriculture which according to his way of thinking had taken a heavy environmental toll. This was particularly so in respect of soil erosion, pesticide runoff, ground water depletion and a heavy reliance on energy and fertilizers which all depend in turn heavily on the use of fast depleting fossil fuels.[7]

Jackson promotes the use of plowing every 3-5 years, use of mixed polyculture of perennials specially on sloping and erodable soils - in place of corn and wheat under present day conventional farming. The average annual top soil loss in US farms is estimated at 15-16 tons an acre or two billion tons on USA's 400 million tillable acres. Wheat production in US on an average was 1800 lb./acre and Jackson has used a variety of plants and grasses approaching the wheat standard although some required fertilizer and irrigation. The polyculture for the Prairies, Jackson is toying with, is one that could fix nitrogen to replace fertilizer use. In addition this would also provide natural protection from plant disease, pests and undesirable weeds. After trials and errors the Jackson group has chosen Eastern gama grass (*Tripsacum dactyloides*) whose seeds are rich in proteins. Another promising plant used is giant wild rye (*Leymus racemosus*) a bunchgrass native to Europe and Russia. The third species, Illinois bundle-flower (*Desmanthus illinoenses*) fixes nitrogen in the soil. These trials are on although earlier Maximillian sunflower (*Helianthus maxmillianus*) had also been tried due to its ability to control weeds since this sunflower plant acts as an allelopathic plant which hopefully may serve to replace chemical weedkillers which we know are serious polluters of the environment. Whether or not Jackson eventually succeeds and overcomes the manifold hurdles, the effort is worthwhile for the world as this shows new possible, unconventional directions, in order to get away from the heavy price the conventional farming has been extracting worldwide.

Ecological farming systems as are being developed and evolved with a widely improved, repeatable, tested scientific knowledge than was the case in the past, should have considerably improved survival power in the future. Recent archaeological evidence of Hohokam (USA) land-use practices in around 500-1450 AD for instance should provide answers into how large populations survived in drylands through the interplay of agricultural and environmental systems. These are the issues and answers we need for sustainable agriculture. Many of the complex and intricate canal systems for irrigation or use of dams, canals, trees etc. were obviously aimed at assuring food, fiber, fuel and building materials for a growing population. This complex system enabled the population to survive some 1000 years in the harsh desert conditions through use of suitable trees and nutritious beans from leguminous desert tree species.

Extensive use was also made of a wild desert plant, agave, which was drought hardy and provided food, fiber and building material. Cholla and prickly pear cacti were also used as field borders and in fallow lands and marginal areas. There was perhaps a community use of energy for cooking through use of cooking food slowly with heated stones in covered pits to save trees. Soil conservation and fertility was ensured through trapping runoff fertile sediment, which provided essential nutrients and texture. It seems Hohokam had fine tuned and adopted strategies for providing a stable subsistence and food security on a stable and sustainable basis and to reduce risks.[8]

Barry Costa-Pierce also has described in some detail the ancient prehistoric Hawaiin aquaculture which combined fish production and animal husbandry possibly as early as 14th Century. As per records of Captain James Cook in 1778 there were some 360 fish ponds producing some 900,000 kg. fish per year. By 1985 only 7 such ponds remained in use obviously due to neglect of traditional aquaculture by our scientific community.[9]

Sri Lanka also had its start around 543 B.C. and the traditional farmers would prepare their fields only after the appearance of the migratory Pitta bird. [10]

Prof. F.H. King in his fascinating and historical book Farmers of Forty Centuries first published in 1911, has also left behind a fascinating story of permanent agriculture in China, Korea and Japan without use of petroleum based energy intensive or chemical based agriculture -- agriculture that was obviously truly sustainable.[11]

Obviously such developments and systems would meet even the present day needs and answer questions of what is sustainability. This in effect means that the system to be sustainable must be capable of going on for ever. The inputs required must be always available provided ofcourse that the components of physical environment remain undamaged. Also there should be no need for continual outside injection of resources. Such sustainable systems must be adaptable to any new outside factors that may crop up. These considerations are ofcourse in addition to several other important social, economic and institutional issues–which have also been touched upon briefly elsewhere.[12,13]

We will appreciate as we proceed further, the main foundation of SA is the indigenous knowledge, protected and perfected over the centuries in all areas of agriculture in its fullest connotation. This is illustrated by Quiroz Consuelo in his paper dealing with local knowledge systems which contribute to sustainable development[14] and by Hemanthi Ranasinghe in his dealing with the subject of traditional crop practices in Sri Lanka.[15] These and other related issues also form part of a recent Pesticide Action Network Conference on Food, Culture, Trade and Environment: Citizens' Partnerships for Food security, Sustainable Agriculture and Safe Food in the 21st century . The Conference has come out with the Seoul Declaration, calling amongst others, for the restoration, conservation and utilization of our traditional varieties of food and forest products.[16]

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Chapter - 9
Integrated Pest Management

We have touched on concepts and application of alternative agriculture (AA), sustainable agriculture or synonymous agriculture (SA) which caught the imagination of the affluent West which now seems to retreat to the traditional, indigenous systems but obviously without fully acknowledging the same. It is perhaps in this background that a new vigorous emphasis on integrated pest management (IPM) has sprung up to replace or partly offset the damage and dangers created by conventional agriculture already covered in considerable detail. IPM is basically a practical, alternative approach to solving pest problems. It is an offshoot of ecological considerations and has been in use for the past 30 years in both rural agriculture and urban settings and is in response to the not so pleasant, costly experience with "conventional" chemical pest control approaches which emerged in a big way during World War II. The US National Research Council has now accepted IPM as the basic foundation of the entire SA movement. IPM is also synonymous with IPC (integrated pest control) and FAO (1967)[1], defines it `as a pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilises all suitable techniques and methods in as compatible a manner as possible and maintains pest populations levels below those causing economic injury.' It is not simply the juxtaposition or super imposition of two control techniques but the integration of all suitable management techniques with the natural regulating and limiting elements of the environment.

The US Federal definition (1979) of IPM is-the selection, integration and implementation of pest control based on predicted economic, ecological and sociological consequences. The IPM concept was perhaps first introduced by V.M. Stern et al. in 1959 -(Hilgardia, 29: 81-101 quoted in NRC 1991).[1] However,

in 1953 A.R. Picket and Patterson -(quoted by Michael Hansen, IOCU, 1987) developed a programme during mid-thirties to mid-forties to control severe mite problem on apples in Nova Scotia, USA.[1A] The office of Technology Assessment USA, (1990) has defined IPM as "The optimization of pest control measures necessary in an economically and ecologically sound manner accomplished by the coordinated use of multiple tactics to assure stable crop production and to maintain pest damage below the economic injury level while minimizing hazards to humans, animals, plants and the environment."[1]

IPM has been considered basically as a decision-making process which needs regular monitoring to decide on treatments and employs physical, chemical, mechanical, cultural, biological and educational facts to keep pest numbers low enough to prevent excessive damage or annoyance. IPM, unlike the conventional system, does not depend on a predetermined calendar schedule. IPM as we will see through some examples, has been developed for many crops and plantations, resulting in considerable decrease in pesticide use. It has been applied successfully in cotton, corn, alfalfa, soybean, citrus, walnuts, apple, pears, vegetable and several other crops. In urban areas, IPM has been used to control insects, vertebrate disease and weed pests in parks and gardens, on shade trees, in residential houses, office buildings, hospitals, schools and restaurants etc., with notable success in reducing pesticide use. For instance in 3 years time (1980-83) using IPM, the US National Park Service reduced pesticide use by 70 per cent. Similarly in forests, with cyclic outbreaks of pests over large areas, IPM has helped considerably in checking pests like the gypsy moth, spruce budworm, pine beetle and Dutch elm disease caused by fungus.

The rationale of use of IPM has been encouraged by the undesirable over-dependence on pesticides and the many deleterious effects associated with them. IPM is not intended to intervene or interfere if indigenous methods such as cultural, physical or other practices are working effectively. This is particularly true in the case of subsistence farming in countries like India. Pesticides are in some cases used sparingly in association with other non-pesticide method(s) or different pesticides are rotated to discourage the build-up of pest resistance. In other situations there is increasing use of pesticides as in the case of cotton largely due to increase in pest resistance. Finally there is also a recourse to the heavy use of pesticides to meet the crisis caused by increased pesticide use and resulting enhanced resist-

ance, destruction of natural controls including problems of the appearance of new pests as also resurgence. This has happened in respect of vegetables and cotton amongst other crops. Once it is clear that pests cannot be controlled and IPM is called for, various points will have to be decided and choice of methods, techniques and a strategy has to be worked out. This must take into account, the need for least disruption of natural controls–use of chemicals which are least inimical to human health as also to other non-target organisms and the general environment. The operation should aim at cost effectiveness and hopefully offer long-term redress.[2]

In working out a treatment strategy referred to above, consideration needs to be given to various factors and situations–as has been worked out under USA conditions by the Bio-integral Resource Centre. These are the major strategies for consideration and available although there is always room for innovation.[3] It is generally accepted that there are 6 important components of a successful IPM programme:

- Initial collection of information
- Monitoring
- Determination of injury levels
- Record keeping
- Selection of least-toxic treatment and lastly
- Accurate and elaborate evaluation of the programme which would help it in the future.

In other words IPM combines genetic, biological, agronomic and chemical approaches making up a strategy that is not only sustainable over a time-frame but also least damaging to the environment.[4] A somewhat parallel strategy of integrated nutrient management is being applied increasingly, aimed at reducing dependence on chemical fertilizers in favour of organic sources of nutrients. In less productive systems such as marginal areas, there has been age old reliance on low-input systems as often there are no other viable alternatives. Combined with agro-forestry, low water and other inputs, these may offer viable long-term sustainable answers to the situation.[5]

The importance of effective control will become evident when we consider that current global losses due to pests, which include insects, nematodes, diseases and weeds, is estimated at US$ 300 billion each year. This works out to about

30 per cent of potential world food, fibre and feeds. As per one estimate losses annually in grain crops alone exceed the food grain deficits of the developing world. Also the world expenditure on pesticides during 1988 was over US$ 20 billion, with herbicides accounting for 8.9 billions, followed by 4.2 billions on fungicides and 1.3 billions on the rest.[6] Let's have a look at pest management in the developing countries especially in the tropics where perhaps pest activity is the highest on account of dynamics of agro-ecosystems as compared to temperate climates. This apart there are potential socio-economic benefits and of course lessened health hazards, which are routinely and strictly being followed in the western world for a variety of reasons, which seem to be absent in the third world in general. Take for instance the case of Brown plant hopper which is a serious pest of rice and is under chemical control in temperate Korea or Japan. On the other hand this serves as a super-pest in the SE Asian tropics, which really indicates that destruction of natural enemies in temperate rice fields obviously had marginal effect as against the situation in tropical rice fields.

Rice as is known is the staple food of some half of the world population and is grown in 148 million ha. of land globally, with 132.6 million ha. in Asia. India with 42.8m ha has the worlds largest rice growing area - some 28.9 per cent of world's total annual production of 72.61 million tons. The average yield (1991-92) was 1.706 tons/ha which would earn it the 18th rank productivity -wise with North Korea leading as the the first at 6.51 T/ha. followed closely by South Korea and Japan with the world average at 3.19 t/ha. Incidentally the average for Asia is 3.27 t/ha and 1.71 t/ha for Africa. It is in this background that with such low yields, the use of chemicals is quite often counter productive.

Asian rice is *Oryza sativa* L whereas African rice is *Ozyza glaberrima* L with both possibly having a common ancestor. Most of the traditional Indica varieties are low in fertility and adapt towards poor weather conditions and irregular water regime. Generally these do not respond to intensive cultivation with high inputs. These are also tall varieties with profuse tillering, long maturity periods and have traits of resistance to endemic pests. In Asia alone there are about 120,000 known varieties. IPM entry in rice more or less coincides with the introduction of High Yielding Varieties (HYV). *Japonica* varieties are short-stemmed with shorter maturity and respond well to

inputs. The HYVs have parentage from both groups. Although HYV coincided with the introduction of fertilizers, it was after 1961 when IRRI started its breeding programme that the real impact was felt. Rice is grown under 5 eco-systems-one of which the irrigated ecosystem—has suffered the most damage on account of introduction of HYV (52.8 per cent of total area) as also due to deleterious effects from technologies needed to grow HYV. Of the total areas, 47.2 per cent which are rainfed, have been relatively unaffected. These areas have also not benefited from the green revolution. In Asia most of the rice is grown under irrigated conditions while in Latin America and Africa it is mainly rainfed. In India 60 percent of the area is rainfed as against the 90 per cent irrigated area in China.[7]

There are over 100 insects, 74 diseases and 1800 weeds associated with rice in Asia. Of these 30 insects, 16 diseases and 15 weeds are considered important. This is exclusive of some 82 micro-organisms which are considered injurious to rice from a breeding viewpoint (40 fungi, 20 viruses, 12 bacteria, 8 nematodes and 2 mycoplasma like organisms). Of this group 20 are considered important in breeding work.

There is a wide variety and range of pests in these 5 eco-systems which include BPH, armyworms apart from soil insects such as ants, termites and white grubs in upland rice. Estimates of losses are as high as 50 per cent (Cramer, 1967) although these estimates vary from country to country and year to year.[7] In addition there is a wide range of weeds and weed losses in Philippines. The empirical data in Philippines clearly indicates that the first of the Green revolution varieties IR8 released in 1965 and grown widely, led to a measurable increase in plant protection problems with relatively minor pests becoming noticeable in fields . Green leaf hopper (GLH) and brown leaf hopper (BPH) became major problems, the former as a vector of Rice Tungro Virus (RTV) and the latter as a direct result of insecticides killing its natural enemies, leading to pest resurgence. Thus there seems to be a strong correlation between HYVs, percent of farmers using synthetic insecticides and BPH emerging as a dominant insect problem in several Asian countries as had been predicted by some scientists at IRRI itself–voices which were not heeded at the time. It is no coincidence therefore that BHP is now commonly referred to as a Green Revolution Pest.

The Green Revolution technology was institutionalised with an important and effective Government program in 1971-

72–*Masagana 99* which included provision of credit and extension advice with HYVs and agro-chemicals. The programme was initiated by International Rice Research Institute, (IRRI) Manila with special grants from the Rockefeller Foundation. Masagana means beautiful and 99 was the target yield expressed in cavans (a bag of about 100 lbs) or about 4.3 tons/ ha. In fact many farmers exceeded 99–reaching 145 as against the traditional farmers who produced no more than 40-65 cavans at that time.

The success of the programme was due to strong Government support headed by President Marcos who launched the Programme in 1973 as a priority project on TV. The Government bought and provided more than 1,000 motor bikes. More than 600 million pesos were loaned to small farmers during the 1974 and the programme covered 900,000 ha in 1974 against a target of 1.2 million ha.[7] Apart from the massive promotional campaign, credit and Government support, there was necessary technology, adequate trained and mobile field staff, supply of assured inputs and above all assured marketing with adequate returns to farmers. The programme had its impact not only in Philippines but its message travelled to India through powerful official contacts in IRRI. It also moved to Peru for "Cosecho 60" for soybeans or Minon 60 for rice in Japan and other countries. The "*Masagana 99*" like its analogues in other countries, recommended calendar spraying of 5-6 pesticide applications per season, blind-foldedly, regardless of any pest infestation. Agrochemical companies took full advantage by promoting insecticides as a yield-enhancing rather than as plant protection aid.

Thus in 1973 some 80,000 ha of rice suffered substantial losses from hopper burn in Laguna province, a predominantly irrigated rice eco-system which was a target area for the deployment of HYV. This also debunks the institutionalised approach to agricultural development. More recent data from IRRI show that there were no significant differences in yield (1987) between fields where no insecticide was applied and fields with 1-6 insecticide applications in Central Luzon in Philippines.

It has also been brought out that although hopperburn appeared on a large-scale in Philippines in 1973, it had been observed there first in 1969 on IR8, IR17 and IR20 and the response was more insecticide, apart from screening BPH for

resistance. More varieties followed- IR28, IR29 and IR30 with basically the same gene. Resistance conferred on these rice varieties lasted 3-4 seasons followed by heavy losses due to BPH in Luzon in Philippines and Mindanas and in Indonesia. Once again IRRI responded by another strain IR32 which protected rice from BPH for 3 years, 1975-78. This has been ascribed to increased area planted to HYVs as also due to increased fertilizer use.

At this stage it was suggested that BPH could be managed by using pesticides based on thresholds derived from field scouting–an important feature of todays' IPM. This system has been accepted in 1986 in the Philippines, with active public support from the President. In Indonesia, a Presidential Decree in November 1986 not only endorsed IPM initially for about a million hectare, of rice threatened by BPH and RTV but a ban was also imposed on the use of 57 broad spectrum pesticides. Recent unconfirmed reports point out, however, that the ban was not on imports or manufacture but only on use. If correct, this would make a mockery of the ban.[8,9,10,11]

In India IPM was officially accepted as the cardinal principle in the 7th Plan (1985-90) and later repeated in the 8th Plan document. In the Annual Reports of the Ministry of Agriculture, ritualistic reference is made to IPM as also to biological control as a routine, as a goal for plant protection. Government agencies have on the other hand, in fact, embarked on several projects for promoting alternatives to pesticides in farming and even supported mass production of biological control agents through pilot projects at some of the agricultural universities. As recent as March 15, 1995 in the Economic Survey of the Finance Ministry under Agriculture, the Government has made the following statement in the Indian Parliament:

> Item 58. In view of the safety of the ecosystem and the environment, the policy is to follow integrated pest management as a thrust area in the overall crop protection programmes during the Eighth Plan period. The consumption of pesticides is estimated to be 83,000 tons as compared to 69,463 tons in 1992-93. Bulk of the requirement of pesticides is met through indigenous production. During 1993-94, about 5,000 extension functionaries and 3,000 farmers have been planned to be trained in IPM for rice and cotton.

Item 59. A National Conference on IPM was held in March 1994 to finalise IPM training/demo programmes with State authorities. Similarly use of bio-pesticides is now being actively studies. Technical and financial support of international agencies like FAO, UNDP and ADB-CABI is being sought to promote IPM in India.

As is generally the case with our bombastic policy statements, the above statement is self-contradictory since the government has made every effort to the contrary and provides for some 20 per cent increase in use of pesticides. There is also a bloomer in the above statement (by the Finance Ministry) obviously prepared by the Ministry of Agriculture which by all accounts is wedded to the pesticides and its powerful vested interests and has accepted the theory of certain famine and starvation in the country if pesticide use was stopped or even reduced. This would help explain why during 1993-94 about 5,000 extension functionaries and 3,000 farmers were planned to be trained in IPM for rice and cotton. In the item 59 a reference is made to a national conference on IPM held in March 1994 to finalise training/demonstration programmes with State authorities. Likewise the statements say that the use of biopesticides is now being actively studied forgetting that this has been going on for over 10-15 years already without any results having been transferred to the field and farmers. This is amply evident from the ever increasing use of chemical pesticides. Further a look at the Proceedings of the National Conference shows that the main concern of those who assembled was the need for creating effective laboratory facilities for ensuring that the pesticides on the market were not adulterated.

The bottomline of the above policy statement in this important document, the Economic Survey for the year 1994-95, is the technical and financial support of international agencies like FAO/UNDP/and ADB-CABI to promote IPM in India. More about this later.[12]

In Sri Lanka, IPM was adopted in 1987 and the now well-known Travel and Visit (T&V) extension programme was initiated. The Malaysian government has likewise pledged their support to the IPM programme and its use extended from rice to other crops. Thailand has already a number of FAO programmes dealing with IPM in rice, vegetables and fruit crops while Bangladesh is perhaps yet at an early stage. It

appears China and Vietnam are the 2 potential participants for adopting IPM. One of the traditional age old method for plant protection has been improvement in Host Plant Resistance (HPR) through selection or now through breeding technique and use of germplasm with specific resistance to known pest and abiotic stresses. In fact this was the idea behind release of various pest resistant varieties developed by IRRI such as IR36 which was resistant to BPH. However, there have been pitfalls as shown by the blast epidemic in South Korea (1976-79) which overcame HPR in Tongil type rice varieties (1986) with serious political and social consequences. Obviously there are lurking suspicions on the HPRs capacity to hold up. It is clear that dependence on a single gene type vertical HPR needs to be looked into as there are some weaknesses in our approach.

It is obvious that a fresh look at some of the traditional rice varieties which have proved more stable to attack, is called for. Such rice varieties are obviously in certain areas in the Philippines as also in India and other countries and new approaches are needed through R&D to fully exploit such germplasm to develop HPR while at the same time fully using the alternatives offered by biological control, bio-pesticides, mechanical and cultural controls apart from any other successful traditional practices.

By and large the IPM has relied on need-based use of pesticides and a fallow period in the rice eco-systems which has resulted in savings from reduced pesticide use and in some cases even increased yield. However, more recent and effective methods such as use of microbial pesticides -*Bacillus thuringiensis* has had limited use in rice. Biological control of plant pathogens in rice has not been used in general even though sheath blight control trials with bacteria had proved successful at IRRI. In China baby ducks are let off in rice paddies to devour insects and weeds. Mechanical control for weeds has also been used successfully. There are other cultural and traditional practices such as the use of certain plant parts in rice fields to repel insects or burning to kill pests in top soils apart from planting pest resistant varieties.

Some of the issues arising from the foregoing as brought out by Peter Kenmore[6] are that if one rice crop follows another there are high possibilities of pest attacks due largely to input packages of agrochemicals. Therefore rotation in

crops is desirable with legumes, maize or vegetables as also growth of crops on bunds as in South India.

Yet another problem is of weeds which are controlled by flooding, tillage, physical removal and herbicides. Rats are another serious problem controlled through burrow destructi-on and rodenticides. The main problem however is insecticide-induced resurgences of BPH which has followed unnecessary broad spectrum insecticide use. Thus the key to success of IPM is to ensure minimum destruction of predators so that pests like BPH do not explode. It also seems that farmers think of insecticides as a fool proof medicine and cure and quite often these carry high subsidies and are issued without any payment as in Bhutan . This results in the farmers using pesticides upto 20 times per season as against the 2-4 times needed. In effective scientific pest control the critical input is pest surveillance, which in effect also means training at all levels. Considering that insecticides represent 5-15 per cent of farm production costs depending on levels of subsidies, it has been calculated that IPM saves some Rs.400 per ha. per season in India (about US$ 26.60) , the highest amongst the 6 South East Asian countries studied.

This programme for example operates in 16 States in India and continues to be the major national source of information for pest control not only for rice but also other crops. It uses simple technology with an emphasis on ground accuracy rather than sampling precision. There are similar programmes in South and South-East Asia with varying degree of emphasis and success . Pesticides used for rice, unlike those for corn and cotton were not developed for rice and most of these are highly toxic to fish, shrimp , snails, frogs and other aquatic species, which are often used by farm families . These are highly toxic and it is difficult to render them safe in rice cultivation because of small farm size and the nature of rice production.

Rice in fact is not an important market for most pesticide producers for which Asia accounts for less than 20 per cent of the world market. In Asia insecticides comprise about 70 per cent of the pesticides sold by value. In fact there is greater need for herbicides than any other pesticides for rice. Perhaps the only new insecticide developed for rice is buprofezin (Applaud). To make matters worse in many countries especially where these are subsidised, purchases are made by Govern-

ments rather than farmers. It is expected that after IPM is adopted by the trained farmers there is bound to be a 50-90 per cent reduction in pesticide use. An example of the lack of concern on the part of the manufacturers is the sale of molluscicides in Philippines (approx. annual sale US$10 million) which are widely used in rice but are registered only for cleaning of streams and ponds. There are widespread reports of damage to the toe nails and finger nails of rice farmers and labour and shredding of water buffaloes used as draft animals.

Intensive pesticide use has been shown to breakdown pest resistance in new varieties. By reducing dependence on pesticides, the life-span of crop varieties is increased enabling the continued use of popular varieties, increasing farmers profits. This new national programme has come to be known as Kasakalikassan–quite far removed from Masagana 99 Program.[13 17]

Success has also been achieved in pest control through IPM in rice in Indonesia after the President in 1986 put a ban on 57 out of 63 registered insecticides for use in rice after it was found out that their indiscriminate use was destroying beneficial predators and parasites of rice pests, which permitting unrestrained growth of noxious pests. As in Philippines, extensive training programme was started apart from stopping pesticide subsidies of about US$120 million a year. In 1991, rice production was the highest in Indonesia's history with 13 per cent increase from 1986 levels. Pesticide use had fallen by 60 per cent. The cost of loss due to BPH outbreaks cost US$1.5 billion. Health risks to people and environment decreased as also pesticide food residues.[18]

Pesticide production fell from 58,000 tons in 1986 to about 20,000 in 1991, whereas rice production rose from 27 million tons to 31 million tons in 1991. Results from Bangladesh and China gave a similar picture where reduction and changes in pesticides use did not lower rice yields. The benefits of IPM as analysed by Kenmore are manifold. It offers several environmental and ecological benefits and in addition it reduces fluctuations in production due to pests as in Philippines and Indonesia over the last 3 years.[19,20] IPM protects natural enemies–predators and parasites and prevents the resurgence of pests. Also IPM helps in reducing deleterious effect on aquatic life and aquatic protein foods as also contamination of underground water supplies. In China , for instance, after

the switch over from chlorinated to organophosphates and reduced levels, the level of residues in human tissues have gone down. There are economic and sociological savings as well as reduced human health hazards. Michael Loevinsohn (*Lancet*, 1987) for instance shows that in Philippines the incidence of non-homicidal, non-accidental deaths in males aged 15-45 were several hundred per cent higher in rural as compared to urban populations during the time Endrin was available as a major component for use against rice pests. As soon as Endrin use ended, through a ban, the difference between urban and rural populations disappeared. Taking these findings together with informal surveys in Asian countries suggests that the number of people in rice farming in Asia poisoned by insecticides every year must be in the hundreds of thousands. At least in India due to the lack of a working notification system pesticide poisonings must be staggering considering India has the largest area in the world under rice. While discussing sociological factors some of which are location specific, the role of bureaucracy both at Headquarters and field as also collusion with vested interests represented by manufacturers and distribution agencies etc., stands out. Not surprisingly Kenmore points out the negative role of Agriculture Ministries which in many cases is in sharp contrast to the more liberal role and broader outlook of other Ministries like Environment, Biotechnology, Finance, Education, Planning etc. The writer here refers to the need for NGOs and pressure groups to assert themselves. A reference to these issues and other constraints will be made separately elsewhere.

Lets have a look at application of IPM to Soybeans in Brazil, a rainfed crop grown mainly by well-off farmers in summer in rotation with winter wheat. Major pests and diseases faced were the Soybean caterpillar, which through defoliation claims losses of upto 80 per cent. Other pests were the stink-bug complex of pod and seed suckers and pests which caused foliar and fungal diseases apart from weeds. Control measures included monitoring, cultural and mechanical practices, including the use of early maturing varieties specially to prevent damage from stink-bugs, use of trap crops to escape thrips which also serve as vectors of virus diseases.

Varieties resistant to stink bugs, foliar diseases and some with resistance to nematodes were released. The system also depended on knowledge of occurrence and use of natural enemies (in this case an entomagenous fungus).

A nuclear polyhydrosis virus was also used to cover one million ha. Although weedicides were used, in some areas cover crops such as black oat or millet was used to a limited extent to reduce weed incidence. Use was made also of weekly television programme apart from the use of field manuals and training to farmers through posters. Uptake of the IPM technology now covers 40 per cent of farmers, an area of 1 million ha. with an estimated savings of over US$200 million annually due to reduced use of inputs, including pesticides, labour and machinery. In contrast to the national average of 1,760 kg/ha. the yield was 2,200 kg/ha in the State of Parana. At the official level, the utility of IPM was assessed on the basis of importation costs of fuel and imports of chemicals. The number of pesticide applications was less than 5.8 per season to less than 2.0.

The backbone of the IPM programme–training, has been excellent [21,22] Several pesticides have been banned. The constraints identified included weak extension services as also lack of R&D inputs and lack of information on weeds. There was also lack of knowledge on economic injury levels for insects causing any new problems specially in central Brazil. The following is the story of Sweet potato on Penghu island in the Taiwan straits where peanut is the other major crop grown mainly from March - September in rotation. The crop is rain fed and is mainly grown by subsistence farmers who are generally part-time fishermen. The pest faced is the sweet potato weevil, *Cylas formicarius* and is highly destructive and even though the pest is endemic in tropical/subtropical regions, no control measures are taken even though slightest damage to the tuberous roots makes the crop unfit for human use. The plan of control followed was the use of sex pheromones to mass trap the male weevils and also thereby to estimate the level of weevil population. Other method adopted were the use of cultural methods, which include crop rotation. The cleaning of weeds (*Ipomoea*) was undertaken as also the use of weevil free cuttings and use of tender shoot cuttings as older stems carry weevil eggs. Soil cracks were covered up to prevent entry of the weevil to the roots.

The cuttings were dipped in insecticide solution (0.05 -0.1 per cent) before planting. The project in which 90 farmers participated is considered successful as the quality and profitability of the crop was greatly improved, although not the yield.

Pasture Grasses (Costa Rica)

In the central plateau of this country as also in the tropical Savannah along the Pacific coast, pasture grasses are grown for dairy cattle of Indian origin. Pastures are raised and maintained continuously and there are no inter-croppings.

The major pests and diseases include spittle bugs, whitegrubs, grass looper and weeds (sida, bidens, Lantana and Rottboellia). Prior to the IPM programme a variety of pesticides were in use indiscriminately.[23]

Spores of an entomogenous fungus of *Mucor* species was introduced for biological control against spittle bugs and no pesticides are used. A number of cultural practices were introduced which cover addition of phosphorus and potassium in addition to nitrogen -- low mowing of pasture and intensive grazing were introduced to reduce numbers of pests and avoidance of humid micro-environments. In addition new resistant varieties developed at CIAT were being introduced. IPM has been used by over 200 farmers covering over 15,000 ha. with excellent results. While the IPM system costs 125 Costa Rica Dollars ($C), the conventional cost was $C6000. As has been mentioned earlier rice is grown under irrigated and rainfed conditions as also in deep water and tidal wetlands. Generally it is grown as a monocrop in 1-3 crops a year. In some places it is also rotated with wheat, soybean maize or groundnut. Rice yields vary from region to region and country to country as could be anticipated. There is also wide variation and increasing use of HYV in various countries. These are generally semi-dwarf, with stiffer straw, faster maturing and more responsive to fertilizer. Also these require other assured inputs like pesticides, irrigation.[24]

Rice in South and South-East Asia

Major pests of rice in the above areas include, stemborers and leafholders. In addition there is Tungro, a virus disease vectored by 5 leafhopper species, stunt virus vectored by brown planthoppers, the orange leaf virus and yellow dwarf virus. Sheath blight, blast, brown spot and false smut also occur apart from weeds, rats and birds and lastly the golden snail. [25]

In Asia which accounts for less than 20 per cent of the world market for pesticides, 70 per cent are insecticides. Pesticide use is heavy in some areas and totally absent in

others. Application of pesticides leaves much to be desired and quite often these are applied below recommended levels.

In Indonesia for instance, rodenticides are officially not recommended, but are widely used, quite often at a wrong time thereby having very little impact. In several, countries there are heavy subsidies in pesticides, including in India. In Bhutan pesticides are currently provided free.[26] It is suspected that secondary poisoning of non-targets has arisen from use of rodenticides. Resistance to pesticides is known for BPH and the green leafhopper. In the Philippines for instance, improper use of pesticides was thought to have led to ingress of BPH. IR26 and IR36 rice varieties of IRRI are no longer resistant to BPH.

A number of monitoring programmes have now emerged including surveillance programmes as also emergence of data for threshold levels. Planting technologies have also been developed such as simultaneous planting varieties with equal growing cycles. Mechanical methods such as removal of snails and use of drives, traps and nets and also trap crops for rodents. Resistant varieties are also in use against blast , BPH and GLH, bacterial blight and gall midge. Pheromones are also being used for monitoring pests.

These methodologies and technologies have yielded results through improved production and reduction in costs of inputs--particularly for pesticides and a corresponding increase in farmers incomes. Savings per ha. per season due to IPM in 6 countries range from US$8.8 - US$23.3. In Indonesia for instance on account of IPM in respect of rodent control in one province, a 3-fold increase was reported.

The improvements have been achieved despite many constraints which range from lack of R&D and extension, general lack of cooperation amongst farmers and the inability of R&D staff to communicate with farmers. Quite often the research lacks focus and R&D work is performed in isolation nor is there a system of reward and punishment for R&D workers. Apart from lack of support from bureaucrats for R&D workers, as in India, there are also reports of conflicts between national and international centres largely on account of a big divide on account of remunerations, work environment and facilities as also modes and norms of accountability.

As has been brought out, rice constitutes the staple food of atleast half the world's population and occupies some 148

million ha. of land world-wide. Quite frequently there have been pesticide related mortalities, many of which go unreported. In Indonesia for instance these have been ascribed to heavy use of pesticides on account of 85 per cent subsidies in early sixties amounting to some US$150 million per year.

In Central Luzon in Philippines there was some 27 per cent increase in insecticide-related mortalities during 1976-82. A similar situation prevails in other areas in Asia. Although the use of biological control agents of plant pathogens holds great future, these have not been used much so far. Nevertheless, use of baby ducks and geese in rice paddies where fowl eat insects and weeds has been practiced in some countries as also stocking with fish. There are other traditional mechanical and cultural practices which do help In Philippines it has been estimated that IPM programmes can generate a rate of return of 25 per cent. In Indonesia the subsidy was reduced from 85 per cent to 15 per cent in 1987 The important point that has emerged is that at the microlevel, IPM farmers while maintaining yield levels have reduced pesticide use by atleast 55 per cent. The IPM farms have thus emerged as generally more profitable than the non-IPM farms in Asia. The farmers have also acquired knowledge of use of simple economic thresholds for insecticides application and some 74 per cent of them do so correctly, debunking the fear that the IPM technology is too complicated for the farmers.

The successful application of IPM in rice in some seven Asian countries can be briefly ascribed to determined R & D support apart from the political will of the respective countries as in the case of Indonesia for instance. After banning 57 of the 64 pesticides when in 1990 a sporadic white rice stemborer began infesting paddy in West Java, despite the persistent clamour for supply of pesticides, the Government did not cave in. Instead some 30,000 people were rallied together to meet the menace through picking up the stemborers small pinhead sized white eggs off from the rice fields and the tragedy was overcome successfully. In fact it turned out that the areas worst affected were those where carbofuran had been applied. Thus the basis of IPM in rice is confirmed as also the observation that the pesticides in effect are promoting pests by killing predators leading both to resistance and resurgence thereby exacerbating the BPH outbreaks. This has been demonstrated at the IRRI rice fields also which reported seven times as many BPH eggs surviving in fields treated with pesticides.

Yet another important step has been the training of farmers especially for determination of the threshold levels of pests and the results of this have clearly demonstrated the effectiveness and the quality of change amongst the trainee farmers. This pioneering lead in Indonesia is rapidly spreading to Bangladesh, China, India, Korea, Malaysia, the Philippines, Sri Lanka, Thailand and Vietnam. Another interesting point that emerges is the need to get away from monoculture as also the need for use of biodiversity and germplasm available in abundance in many countries and now in the gene banks that are fast catching up. In fact it was the indigenous rice seeds, Cisadane and Kreung Aceh which saved the situation in Indonesia when it was faced with a rather devastating and alarming situation on account of failure of rice crops.

These investigations have also brought into focus the shortcomings of the IRRI high yielding seed varieties. It also emerges that high subsidies on pesticides have proven to be counter productive not only in the above cited instance but similar observations have been made in Africa too. In fact as per one report food Aid and distribution of large quantities of subsidized rice under a WFP program in Zanzibar in Africa, has encouraged farmers to slacken their effort in the sanitary practices that are needed for instance to reduce the spread of Sigatake disease in bananas, according to some observers. Similar observations are on record in respect of subsidies on pesticides which in general seem to encourage their misuse or overuse.[27]

At the Centro Internacional de agriculturua Tropical (Ciat),Cali, (Colombia) scientists have developed rice which are resistant to blast, a common disease caused by fungus. As South America's drylands have acid infertile soils, a new variety *Oryzica saliana* 6 has been developed which is high yielding, matures quickly(108 days) and resists rice blast, leaf scald and the sogata plant hopper, which also spreads white leaf, a viral disease. The acid soils usually have high levels of aluminium and manganese which are toxic to crops. Savanna 6 variety, it is postulated, releases organic acid which binds aluminium, preventing it from poisoning the plants. This in brief illustrates how close interaction amongst nations can eventually lick the problems through the sharing of knowledge and eventually help bring well being and defeat hunger around the World as the Ciat proudly proclaims. Several new varieties of rice in

Latin America are pest resistant. In 1990 some 11.5 million tons were grown on about 1,208,000 ha. with an estimated value of US$ 2.5 billions. This situation has resulted in a lower pesticide use from nine to three times per season, adding yet another US$ 209 millions to the farmers income [28,29,30,31]

Vegetables

Vegetables are an important cash crop which in most cases sustains the farmer and his family not only through cash but also for providing the family nutrition. Unfortunately many of these have developed pest problems especially on account of the overuse of pesticides which are being used both for pest control and for purely cosmetic reasons even after the harvesting. This has resulted not only in the problem of pest resistance to pesticides but also high levels of pesticide residues in vegetables and the resultant human ingestion. As indicated in some detail hither to this has created a justified scare in the public mind and led to a demand for organic foods culminating in a movement towards organic farming including home and urban farming, a detailed reference to which would be made later on.

One of the reasons the vegetables have not come under the umbrella of IPM is possibly because these are a rather diverse group of plants belonging to different families and by and large these have been run as small family farms in most countries although the picture has changed considerably especially in view of the heavy demand from the affluent in the thickly populated urban areas . This has been further helped due to the heavy demand for exotic tropical and subtropical farm products especially in western countries not only for vegetables but also for fruits. Added to this is the new trend towards vegetarianism in the hitherto almost total non vegetarian population in western countries.

Vegetable farming has developed into an intensive hand labor farming with a rather high dependence on agrochemicals particularly pesticides. Monoculture is common depending on weather conditions as also on the range and type of varieties available and /or developed, coupled with the location and market needs. Often vegetable pests are indigenous, localised to a region or a country. There are also diseases caused by fungal, bacterial agents and nematodes. Some of the pests encountered are the Diamond back moth, aphids, agromyzid, leaf miners, white flies and *Spodoptera litura* on leafy vegetables. Several

of the pests attack vegetables as well as fruits. For instance tomato pinworm is an important pest in Central America as also in the Caribbean while the tomato-bud fruitworm is common in South America.

Weeds serve as alternative hosts for insects and pathogens although these are not so serious a problem. In general the farmers prefer to choose pest resistant varieties as also cultural practices and use of biological agents such as Bt (Bacillus thuringiensis). In case of vegetables, IPM technologies are in the developmental stage and not very commonly available in most countries. However, for Tomato, IPM has been developed in Cauca valley in Colombia whereas cultural practices are in vogue in many countries. In Brazil for instance disease resistant tomato varieties have been developed and considerable progress in this direction is also visible in Argentina, Chile and Peru.[32]

In India studies conducted by the ICAR's All India Coordinated Research Project (AICRP) on Biological Control during 1989 show that in cabbage native parasitoids, Apanteles sp. and Tetrastich sp., could effectively suppress the DBM while aphids were checked by coccinelid and syrphid predators. Likewise epilachna beetle was controlled by an effective parasitoid, *Pediobius sp.* Inundative release of *Trichogramma sp.* also parasitised eggs of *Heliothis armigera* on tomato as also eggs of *Earias sp.* on okra under field conditions. The plant eating mites of okra, brinjal and French beans could also be effectively controlled by phytoseiid mites with use of some other pesticides for controlling other pests. Use of NPV with vairimorpha could also control pod borer on beans. Similarly fruit borer damage of tomatoes could be checked using NPV of *H. armigera*. Similarly the use of virus plus nematode controlled pod borer and blister beetle in pigeonpea. Similar biological control agents were found successful to check mustard sandfly on radish. Later trials at AICRP, Bangalore (1993-94) and Solan confirmed the earlier results obtained with tomato fruit borer *Helicoverpa sp.* by *Trichogramma sp.* achieving a parasitism of over 45 per cent. In the case of cauliflower and cabbage also at the Solan trial, *Pieris sp.* larvae were heavily parasitised by the endoparasitoid *Hyposoter* sp. and *Cotesia* sp. Use of fungus *Nomuraea* sp. also significantly brought down the larval population of much dreaded *H. armigera*. Yet in other trials Bt formulations were far more effective than use of either endosulfan or control with higher yields. Some coccinellid

predator and *Chrysoperla* sp. were also found to be effective against aphids affecting peas and chillies in the Bangalore area. Likewise use of NPV on *H. armigera* in case of tomatoes has been encouraging in these trials in Bangalore during 1993-94. At Pune, as per the report of AICRP the parastoid *Trichogramma sp.* was very effective in parasiting eggs of potato tuber moth upto a point of 7 metres from the point of release. A maximum parasitisation achieved was 62.5 - 75 per cent when the release was from a distance of about 3 metres and this decreased to about 25.5 per cent at 7 metres distance. It was also observed that the releases of *Copidosoma sp.* and *Chelonus sp.* were even more effective than those of *Trichogramma sp.* in keeping the tuber moth of potato under check. [33,34]

White grub are the larvae of beetles commonly known as cockchafers or chafer beetles. These feed on living roots of a wide variety of plants such as sorghum, bajra, sugarcane, chillies, potato, tomato, ginger, groundnuts, soya bean and sunflower amongst others. These are considered serious pests in several states including Maharashtra and Uttar Pradesh and are rated as one of the pests of national importance. A 13-year (1974-87) study undertaken in Maharashtra clearly established that without any doubt, extensive use of pesticides had aggravated the whitegrub menace as this had disturbed the eco-system and the predatory birds, crows, mainas, lizzards and the toad leading to a flareup of the destructive pest. This situation was further helped both by monoculture crops and the new cropping patterns which in effect had served to provide the white grubs safe sanctuary. In this background recourse was taken to mechanical as well as chemical control methods. The host trees were for instance shaken and sprayed and the white grubs collected and destroyed by putting in kerosinised water or by burning. The mechanical collection was organised during the night hours. In the many crops using this method there was an increased yield in the treated area which ranged from 12 per cent in jowar to 315 per cent in hybrid jowar and 207 per cent in American cotton as against 32 per cent in indigenous (desi) cotton. [35]

IPM of Diamondback moth(DBM) in South Asia including India

DBM seriously affects cruciferous vegetables such as cabbage, cauliflower and Chinese cabbage. Biological control using a parastoid *Diadegma sp.* and Bt have now replaced the use of

pesticides. In addition use has been made also of neem kernel syrup, pheromone traps.

Collaborative Vegetable Research Network for South East Asia (AVNET) has been jointly set up by Indonesia, Malaysia, Philippines and Thailand in 1989. Yet another South Asian Vegetable Research Network(SEARNET) set up in 1992 now links Bangladesh, India, Bhutan, Nepal, Pakistan and Sri Lanka. Both these Networks are being supported by the Asian Development Bank, Manila through the Asian Vegetable Research and Development Center (AVRDC) in Taiwan where the DBM technology mentioned above was first developed. These efforts have now been enlarged through Catie in Turrialba, Costa Rica and Pan American Agriculture Scheme at Zamorano with USAID support.

In the Philippines alone this technology is expected to result in cost reduction of some US$ 10.5 million for 7000 ha. over three cropping seasons or a saving of about US$ 799/ ha. in the pesticide spraying operations. At the Indian Institute of Horticulture, Bangalore, DBM is reported to have been controlled through growing bold-seeded mustard as a trap crop, release of the parasitoid and spraying with 4 per cent Neem seed kernel extract (NSKE). Only three such NSKE sprays are needed according to the trials carried out. [36,37]

Ipm in Cotton

It may be of some historical interest to recall the results of a study undertaken way back in (1972-75) by ICAITI, Guatemala, in 5 Central American countries, which covered in addition to Guatemala, El Salvador, Nicargua, Costa Rica and Honduras. [38] This painstaking and detailed study had drawn many interesting and far reaching conclusions in respect of the effectiveness of IPM and recorded significant reduction in pesticide use. The report had also shown widespread occurrence of poisonings from pesticide use, creation of resistance in vectors leading to a steep increase in malarial cases, a situation which is happening in many countries , including India even today. These studies had also reported serious contamination of milk and beef with pesticides and other associated environmental health concerns including effect on marine life, contamination of water and the environment.

How sad that this rich scientific data which had also found application in cotton in these countries as also in Egypt

did not spread to this country. And imagine we have had to take recourse eventually to the same remedies for meeting almost similar and identical problems and at an enormous cost. In Egypt, for instance, trials on control of cotton pests such as *Pectinophora* sp. by slow release pheromone formulations has resulted in increased honey production as well as an increase in boll weights. Further, the cost of pheromone needed was lower by about 20 per cent apart from other obvious advantages to ecology. Incidentally pheromones are generally used for scouting and monitoring operations for determining threshold levels. [39,40]

Cotton, a cash crop is widely grown throughout the tropics, sub-tropics and warm temperate climates both as a monocrop and in mixed cropping. Cotton is also one of the most heavily pesticide treated crop. For instance in India some 55 per cent of the total pesticide used is for this crop. In some countries like Egypt this percentage is as high as 75 per cent although the world average is estimated to be about 25 per cent which is considered to have led to not only creating resistance, resurgence but also new pests. In India, for instance, so desperate was the situation created some 3-4 years back especially in the state of Andhra Pradesh that despite emergency imports of pesticides, some of which were not even registered in the country there was a widespread devastation of the cotton crop by *Helliothis* bollworm. This led to a number of suicides amongst farmers out of sheer desperation and economic collapse. This possibly was one of the reasons for turning to alternatives to pesticides in cotton in this country and especially towards biological control agents which had shown their worth in other countries years earlier.

As is well-known there is a wide range and variety of pests around the world which damage the crop. Even within a country there are wide differences in the causative agents of the damage, which points towards the necessity for a clear and deep understanding of the situation, the disease and remedial action. Another problem is that a pest is not host specific and the same pest may cause a wide variety of damage in crops and vegetation. All this means close monitoring, scouting, identification and paying attention to the threshold levels. Thus it seems that the same or in fact greater care is needed for biological control operations as in the case with judicious use of pesticides. In other words this means in effect a need for training of farmers as also extension workers and a

close interaction with the R&D staff.[41]

Cotton is attacked by a wide range of bollworms, boll weevils, aphids, bacteria etc. and fungi. Inundative releases of *Trichogramma* sp., *Chrysopa* sp. and NPV in India have yielded encouraging results. For instance in the trials conducted at Hyderabad, it was found that a cost benefit ratio of 1:6.27 could be achieved through IPM as compared with a cost benefit ratio of 1:3.46 with the intensive use of pesticides. It was also recorded that using IPM could double the benefit as against use of 30 insecticidal sprays in conventional farming. Moreover cotton yields were higher in the IPM regimen. In trials carried out at Ludhiana, Coimbatore and Anand , similar trends were observed. Thus all these trials conclusively show that effective control of bollworms is easily achievable using IPM strategy. The IPM module in addition also brought down the incidence of some sucking plant pests like aphids, thrips, whiteflies and jassids both at Anand in Gujarat and Pune in Maharashtra. Trials conducted with Bt. at Ludhiana also demonstrated successful control of Aeries sp. larvae. Release of *T. chilliness* Bo-C strain against *H. armigera* in cotton in Karnataka, Andhra Pradesh and Tamil Nadu showed a high degree of parasitism against the bollworm as reported by the AICRP. [42,43]

IPM world-wide COTTON

Cotton growing in Zimbabwe has received a boost due to an evolution of a new management methodology that countered red bollworms and red spider mites- two important pests that can cause upto 60 per cent and 40 per cent losses respectively. Once again the wide use of pyretheroids had escalated pest incidence through destruction of indigenous predators. Also the new cotton variety introduced to resist jassids was found to be more attractive to whitefly-a situation similar to the one encountered in Sudan.

The technology successfully used in Zimbabwe consisted of scouting of threshold levels of 3 groups of pests-bollworms, sucking pests and leaf eating insects. The second important step was use of minimal pesticide doses which were 2.7-12.3 times lower than in other countries like South Africa, Togo and Australia.

Another strategy used was between-season rotation of acaricides against red spider mites in order to overcome

resistance in mites to the acaricides used. The same was done for within-season rotation of insecticides against bollworms in order to overcome resistance problem. Crop rotation was also practiced in order to reduce damage of soil pests as well as to prevent soil erosion.

Use was also made of available pest resistant cotton seeds. Biological control was achieved through the use of green lacewing larvae which fed on aphids, bollworm eggs, larvae and spider mites. Spiders were used for feeding on bollworm larvae whereas coccinellid larvae and adults fed on aphids.[44]

Crop rotation and removal of weeds helped control these as alternate host plants. Another important method used was adequate potassium and phosphate fertilization to promote strong root development as in the case of Brown spot. Farmer training was considered to be a vital component of IPM methology applied. Cotton yields rose to 2,100Kg/ha. during 1985-86 on the well managed farms of the affluent as against the average cottonseed yields of about 900kg/ha.

Togo which has 82,000 ha and 160,000 farmers involved in cotton, the second most important commodity, is now basically switching over to the biological control on the lines of Zimbabwe. The overall production is not very encouraging as compared to Zimbabwe but the potential is there. Fifty per cent of the farmers obtain 500-1000 Kg./ha, 17 per cent have yields over 1250 Kg/ha and some of the farmers have 1500-2000 Kg/ha.

Until 1989 seeds and pesticides were supplied free under a Government set- up, SOTOCO, combined with a French multinational, CFTC. Fertilizers were provided on credit. Pesticide use has been reduced since 1988 on the pattern of Cote d'Ivoire and Zimbabwe with 2-5 applications, apart from using lower dosages–this helps through saving the natural pest enemies. It seems clear that so far use has not been made of biological agents.

IPM in Cotton in Sudan

IPM nas been in effect for quite sometime here although there are a few grey areas as use of 9-10 sprays per season in the early 1980's, although this is low compared to 30-40 applications in Nicaragua and Australia, mostly by aerial sprays. Whitefly became a serious pest on account of its'

resistance to DDT which led to the entry of other organophosphates which have created same resistance problem. Aphids, bollworm and jassids the other major pests have emerged now.

More recently biological control agents are being used although there is resistance- on account of psychological and ecological dependency apart from vested interests which is helping the continued use of pesticides. IPM in various forms has been practiced since the 1920s and since 1950s scouting and economic threshold levels (ETLs) were introduced. The FAO has entered the fray in supporting IPM, as in Asia and this seems to be helping to revitalise the IPM with hopefully political backing as in Indonesia.

IPM in Rice

'Valle'e du Kou' with 1045 ha is the largest rice area in Burkina Faso accounting for about 25 per cent of country's rice. While in 1973 with Chinese assistance mean yields were 6.5 tons/ha these had earlier dropped to 2.7 tons/ha. In 1987, with new initiatives under Dutch assistance, two rice crops were raised with combined yield of 9.8 tons/ha/year. The major insect pests are lepidopterous stemborers and the white, pink and stalk-eyed rice borers. Rice blast is the most common disease.

The problem is being met through the use of resistant varieties (IR 4456), cultural control and biological control apart from phytosanitary monitoring and threshold levels which has replaced the concept of the fixed calendar spraying. Biological control using 2 larval parasitoids have been introduced although information on natural enemies present has not been made systematically. Pesticide use has decreased by 50 per cent in 1987/88 with benefits from savings plus increased yield levels.

In Madagascar in 1982 a programme, "Taona Zina" (the fertile year) was launched to increase rice production through control of African white rice borer which was estimated to cause damage of upto about 30 per cent, through a programme of pesticide spraying by Ciba-Geigy with Swiss aid. The main rice pests were white rice borer and rice hispid.

In addition there was the problem of weeds and rice-blast disease. The above programme was more or less abandoned and a new programme with Swedish help introduced in 1988

which aimed at weed control, with mechanical or chemical methods giving an increase of 20 per cent in yields. The use of pesticides to control stem borer or rice-hispid was not successful and hence insecticide use was limited only to the nurseries. A pest monitoring system was introduced. Biological control systems are also being introduced in view of their success. Present indications using IPM are hopeful in so far as this helps avoid the recurrence of devastating development of secondary pest species which have been plaguing irrigated rice production in many countries.

Using fish culture to replace pesticide use

Fish in Bangladesh provides more than 70 per cent of the annual consumption of animal protein. In addition to natural insect pests, predators and parasites are found in abundance here. However, pesticide use is almost totally avoided and instead fish like carp and wild fish is grown which pushes up rice yield reducing pesticide use by about 76 per cent. Without pesticide use, apart from fish, growth of aquatics like frogs, shrimps, crabs, snails, mussels and even some beneficial insects seem to come up. Ducks also are introduced, which normally feed on snails and other aquatic plants.[45]

Coloured cotton in Guatemala

In Guatemala 60 per cent of the inhabitants are indigenous people, descendants of 22 Maya Groups, most of whom are farmers. An average small Maya farmer may own approximately 0.3 ha where they grow maize, food crops and brown cotton – the last of these is grown organically and is becoming very popular and fetches very high, attractive prices by the new Greens in the affluent countries of the West. Pests in this situation are not a serious problem except the boll weevil and some caterpillars (armyworms). Two methods are used here- first the catch crops or growing plants which attract natural enemies. Brown cotton is a huge perennial , relatively drought resistant and grows upto 1800 metres above sea level. [46]

Pioneering work is being done in the growing of organic cotton in California, Arizona and Texas as also in Missouri and Tennessee States in the USA. A beginning has also been made at three centres in India, as also in Turkey, Argentina Peru and Australia. As has been brought out later, there have been at least 4 International conferences starting with the one organised in Cairo in 1993 by the IFOAM and two in California followed by

the one organised recently by the Pesticides Trust in Europe which is promoting organic cotton as part of a strategy aimed at pesticide reduction and for creating awareness of the practical aspects of alternatives to pesticides. The Cotton Connection Conference helped bring cotton producers and potential consumer interests together.

Likewise some 250 persons representing organic farmers, environmentalists, cotton ginners, retailers and researchers had gathered together at the second National Conference on Organic Cotton in Visalia, California in September 1993. This was obviously a meeting of minds, a unique cross industry forum to discuss the future of organic cotton. [47,48]

It was brought out for instance that despite the heavy use of pesticides in Sudan the cotton production had lowered to 200kg/acre in 1993 as against some 1300 kg per acre in the 1920s. The first international conference on organic cotton was organised in September 1993 in Cairo, Egypt by IFOAM.[49]

A good deal of the interest in organic cotton has been generated as discussed later on account of the awareness amongst consumers of the health hazards arising from the use of pesticides in cotton which on breakdown are transformed into highly poisonous and dreaded dioxin etc., as has been brought out by the US -EPA Draft report on Dioxins in September 1994, after reassessment. The term Dioxin compounds includes not only the most potent toxin TCDD but also dioxin related compounds such as dioxins, furans and PCBs. German Scientists had found that clothing contained high levels of dioxins in which particularly PCP (pentachlorphenol) was used during shipments. Incidentally PCP has since been banned in India. In the meantime the patenting of transgenic cotton in India by Agracetus Inc. on 27 October 1992, which stirred up quite a hornet's nest of concern has since been revoked by India sometime in March 1995.[50, 51]

IPM in Multifood crops in Western Kenya

The yields of maize, sorghum and cowpea have been relatively low ranging from 2000-2500, 1500-1800,130-300 Kg/ha respectively. These have been traced to losses from pests, incorrect crop husbandry practices and post harvest losses, apart from other factors, including the absence of resistant, high yielding varieties. The early attacks by pod and stem boring insects and the sorghum shootfly are the more common pests

causing losses in these 3 crops. Occasionally armyworm and aphids also attack – for example stem borer losses can run up from 5-83 per cent. In cowpea losses due to pod bugs and borers range from 37-48 per cent. *Chilo* sp. causes 18 per cent loss.

Post - harvest losses caused by flour beetle maize weevils, grain moth and rodents account for some 25 per cent losses. The IPM programme developed consisted of cultural practices such as intercropping sorghum-cowpea with significantly reduced *Chilo* sp. on sorghum, whereas cowpea-maize helped to prevent the establishment of larvae of the cowpea pod borer and maize helped to act as a physical barrier to *Maruca* sp. It was also observed that maize-sorghum intercropping increased stem borer attack on both crops. Use was also made of some 9 varieties with host plant resistance. Likewise some 11 parasitoids of *Chilo* sp. and 9 parasitoids of *Maruca* sp. were isolated. Inundative release of mass reared *Trichogramma* sp. an egg parasitoid resulted in effective control of *Chilo partellus* at experimental levels. Some other promising indigenous pathogens were- *Nosema*–a protozoa, *Panagrolaims*–a nematode, Bt. and *Metharhyzium* sp. and *Beauvaria* both fungal strains

Behavioural manipulation was sought to be achieved using sex-pheromones and a delta trap developed for monitoring, apart from use of synthetic pheromone of *B.fusca* to study the disruption of male-female communication. Using improved and resistant sorghum varieties in farmers' fields as also intercrop and various other strategies indicated above resulted in grain yield upto 61.2 per cent. Although the experimental trials have been successful and promising, these need to be developed and followed up fully with the involvement of farmers and extension workers.[52]

Vegetables

Field Trials conducted at Rajasthan Agriculture University, Banswara by A.V. Thakar et al. (1994) have shown a significant reduction in jassid population in Okra which are a serious menace. Using a neem preparation alone and better still using some 2 sprays of insecticide quinalphos and/ or phosphomidon, resulted in a high yield of 7.281 quintals/ha. [53]

Most vegetables produced in Africa were consumed locally and only 0.6 per cent in value and 2.6 per cent of the quantities were exported by countries in the inter-tropical zone. Tomato, onion, potato and cabbage are the main

vegetable crops, which play a major role in agricultural economics, an important part of traditional African diet and a source of income.

Traditional vegetable growing in Africa was with the use of minimum inputs. However, things have changed with urbanisation and new technologies-improved varieties/hybrids and intensive cropping bringing in pesticides and fertilizers. These in turn led to pest resistance, especially on account of over-use and the use of a cocktail of pesticides apart from the now well established health hazards. Concern of several African countries has led the FAO to carry out surveys in 17 countries specifically in IPM as a possible tool to meet the challenge. [54]

As a result of these surveys, various vegetable pests have been identified and in some countries, R&D initiated on IPM and put into practice. The work is on a preliminary stage but the directions in which this is proceeding will be touched upon here to illustrate the magnitude of the problem.

In Burkina Faso the key pests recorded were *Meloidogyne* and *Paratylenchus* nematodes and Pepper Veinal Mottle Virus (PVMV), a serious viral problem for tomato. Weeds are also seasonal problem as also *Heliothis* sp. Cameroon does not use much of pesticides but cultural and physical control methods are in use. In Cape Verde where pesticides are sold only on a prescription, preliminary work on biological control of *Plutella* sp., a pest of cabbage gave promising results. In Congo, due to bacterial wilt, tomato cultivation was abandoned between 1979-85 although this has since been resumed on introduction of new pest resistant varieties.

Two important nematodes *Meloidogyne* sp. and *Rotylenchus* sp. and nine genera of weeds have been identified to cause serious damage the most important being *Cyperus* sp. Some R&D effort has been on the anvil here as also in Ivory Coast specially in respect of cash crops like cocoa, coffee, cotton etc. but not on vegetables. Similar situation exists in Ethiopia. In Gabon, biological control against scale insects of cassava and mango is being conducted.

In Guinea-Bissau crop rotation and mechanical control as also pesticides are used (these come free from donations). Kenya which has a large cultivation of about 94,000 ha produces about 1.3 million tons (1988) of which about 2%

was exported, used mostly chemical control methods. No wonder pesticide resistance has been observed in several pests to a number of commonly used pesticides like dimethoate, promethrin, endosulfan, parathion and metalaxyl. [55]

The situation in Malawi and Mali is no different. In Senegal on the other hand biological control of Liriomyza sp. with *Hemitarsonemus* sp. and *Chrysonotomyia* sp. has been successful. Work in Swaziland indicates control of nematodes by the use of Kraal manure, use of pest resistant varieties and a 4 year rotation with non-susceptible hosts as in case of tomato. In Tanzania, IPM has just made a beginning as in case of *Xanthomonas* sp. on cabbage whereas in Zaire parasitoid *Epidinocarsis* sp. is in use to control the cassava mealybug. *Phenococcus manihoti* reduced losses by about 5 per cent whereas Diomus sp. established itself only in one area. For control of green mites of cassava, predators of *Neoseiulus* sp. were found to be of value. Zimbabwe had success with the use of parasitoid *Copidosoma* sp. in the control of potato tuber moth whereas Bt was found to be as effective as malathion for the control of DBM. As in Swaziland, use of Kraal manure as also chicken and goat manure were found effective in the control of nematodes . Trials with exotic predator *Typhlodromus* sp. showed that these were effective in controlling red spider mites. Similar other biological control methods were under trial. [56] The release of *Trichagamma brasiliensis* in the case of trials on tomato at Bangalore had also shown parasitism against *H. armigera*.

Sugarcane

Use is made of pest resistant varieties of sugarcane, synthetic pesticides as also the wasp *Cotesia* sp., the fungus *Metarhizium* sp. and some cultural practices. The International Institute of Biological Control located in Trinidad in the past had introduced exotic enemies to other countries since 1947. Trinidad has also taken a lead in developing biological control agents for major local pests which include whitefly, Thrips palmi and DBM active against some vegetables and the froghopper on sugarcane. Trials are also under way using Bt against caterpillar pest particularly DBM, in conjunction with naturally occurring predators and parasitoids.

In Costa Rica to control cane borer (a sugarcane pest) a wasp has been released which lays its eggs in the larval stage of the pest and kills it – but is in no way harmful to the sugarcane or man. A fungus has also been released which grows

on the adult pest, killing it. A simple technique developed is hanging of yellow plastic bags covered with glue to catch the adult pests. [57]

In Pakistan IPM has reduced internode damage from 16 per cent to 5 per cent with biological control. The *Trichogramma* sp. has been found effective against stemborer. An alternative host Sitrotroga sp. has also been released. White grub (Pachnessa sp.) was controlled by harvesting heavily infested fields in May when the white grub larvae pupate and deep ploughing is done 2-3 times before emergence of adult pests. *Pyrilla* sucking bugs were controlled through moth *Empiricania* sp. resulting in 90 per cent parasitism of *Pyrilla*. Some other biological control agents have also yielded encouraging results.

In India major sugarcane pests are borer, *Pyrilla* and scale insects against which effort for development of biological control has been directed at the AICRP (Biological Control, Center ,ICAR). Whereas many parasites/predators either indigenous or imported from countries like Indonesia, Mexico and East Africa have been tried these have not been successful. But success has been achieved through the colonisation of *Epiricania* against *Pyrilla* in Maharashtra, Andhra Pradesh and Ludhiana. Success has also been achieved using a fungus on *Pyrilla* and *Bacillus popilliae* which caused 70.8 per cent mortality of *Leucopholis lepidophora*.

Use of *Trichogramma sp.* against borer (*Chilo* sp.) at Lucknow and Ludhiana showed effectiveness against incidence of the borer. Field trials at Ludhiana of 2 strains of *Cotesia* sp., one indigenous and one Indonesian showed that the indigenous strain performed better against three Chilo sp. of sugarcane borer. However corresponding trials at Lucknow did not show similar trends. Trials in Punjab and Coimbatore with three different Bt. formulations against *Chilo auricilius* showed variable results. Field trials by AICRP in Punjab against sugarcane borer *Chilo* sp. showed that as against loss of 57.6-61 per cent in control areas, the loss in the experimental lots varied from 0.5-12 per cent. At Gangavati the borer incidence in control areas was from 23-63 per cent. Losses from borer attack were higher in control plots at Mandya - as compared to experimental fields. [58,59]

Wheat

Wheat is a rather important crop in the temperate and highlands areas of Latin America and is grown both in rainfed (tropical highlands) and irrigated (temperate) lowlands. In India itself 1990-'91 production was 545.22 lakh tons as against 745.89 lakh tons for rice and total foodgrain production of 1726.29 lakh tons and total cereal production of 1621.65 lakh tons. In temperate climates wheat is a winter-spring crop in rotation with fodder, legumes and industrial crops like sugarbeet, rapeseed and sunflower.[60]

In South America, the major insect pests of wheat are aphids, specially *Sitobium* sp. and *Metapolophicem* sp. which are both vectors of cereal barley yellow dwarf virus disease. *Hyperodes* sp., a stem-borer is a secondary pest. Parasitoids, *Aphidus* sp. and *Praon* sp. have been used successfully to control aphids although recent entry of a new, Russian cereal aphid *Diuraphis* sp. is threatening to disturb this situation. Surprising as this may seem, wheat does not seem to figure in any pest control studies or IPM technology development studies in India.

Maize

Maize is the fourth important cereal crop in India with a production of 90.73 lakh tons during 1990-91. However, like wheat, there are no reports of any biological control work or application of IPM. Maize is widely grown around the world and in countries like Central and South America, it is perhaps the most important food crop grown on a rotation basis particularly with beans and cassava. [61]

A common insect pest to maize is *Spodoptere frugiperde* and in Central America yield losses caused by this may vary from 30-60 per cent. Others such as *Lepidoptera* sp. defoliate the plant and feed on cobs or are stemborers. Some of these include *Mocis* sp., *Helicoverpa* sp. and *Diatraea* sp. Another *Hemiptera*, *Dalbulbus maidis* sp. is a vector of a stunt disease in maize. Downy mildew is yet another disease apart from a wide variety of weeds. Under an AICRP project, field demonstrations were carried out through the release of *Trichogramma chilonis* against *Chilo partelus* on maize in the Bangalore area. The total egg parasitism that resulted was 78.4 per cent as against 0-12.3 per cent in the control area. A recent report from the University of Cornell has reported that a tiny parasitic wasp *Trichogramma ostriniae* from China attacks and

kills eggs of the European maize borer. This has a great potential for control of maize pest major problem in USA as also in some other countries. [62]

Pulses

Trials under AICRP carried out at Hyderabad and Coimbatore showed success for control of *Heliothis armigera* on pigeon pea using *T.chilonis* and NPV of *Heliothis armigera* and the results were as effective as using endosulphan at the level of 0.07 per cent. For chickpea also Ha-NPV against *H armigera* was more effective than using endosulphan. While trials with several commercial preparations of Bt followed by endolsulphan was best in trials conducted at Hyderabad, the Bt formulation alone was effective in Coimbatore trials, showing differences in results depending on local conditions and handling of technology.

Castor

A number of workers have been engaged in the protection of castor from pests in Andhra Pradesh perhaps because this is a popular poor mans crop resulting in considerable distress in case of failure of the crop. Some NGOs in Andhra Pradesh with support and backing from the State Government of Andhra Pradesh, ICAR, Government of India and Oxfam, have used a non-pesticidal approach. For instance in Mehabubnagar District light traps and vegetative traps were used to protect castor from Red Hairy Caterpillar (RHC). This is a rather low-cost technology, an important factor in these areas. The production increased by 80 per cent to 200 per cent per ha.. Castor semilooper which is a major endemic problem has been contained by these NGO groups (AWS and Oxfam) who have evolved successfully a package of pest management practices through the use of indigenous technology- release of egg parasite (*Trichogramma sp.*) followed by NPV spray. [63]

Parasitoids and parasites have also been successfully used at Ludhiana to control the mustard aphid and similar success was reported from AICRP trials at Hyderabad. The use of *Cheilomenes* sp. alone to destroy the pest eggs was so successful the release of *Trichogramma* species against sunflower was not considered necessary.[64]

Coconut

Coconuts in the Third World are an integral part of life and

sustenance and provide cooking oil, margarine, soap, cosmetics processed foods and coconut milk and juice and these are again used as ingredients in a wide variety of foods and cooking. Coconut also provides ropes, twines, rugs and mats.

In 1968 six south pacific countries, last some US$112 millions on account of damage from rhinoceros beetle, which seriously affects production of coconuts by leaf damage. The beetle is possibly native to Sri Lanka wherefrom it travelled to the South Pacific islands. In 1963 the beetle was afflicted in Malaysia with a lethal viral disease which was later identified as the *Baculo* virus, *B.orycts*. From 1970 onwards the virus is being successfully used to overcome damage from the beetle, reducing damage very substantially. This is often quoted as a significant success story of biological control. Trials in India show that biological suppression of 2 key pests of coconut palm, *Rhinoceros* beetle and leaf eating caterpillar is feasible using viral/fungal pathogens for the former and parasitoids for the latter, respectively. However as per Pillai, field scale bio-suppression is yet to be undertaken. This is strange since the *Baculovirus* has been successfully used as indicated earlier in neighbouring South pacific countries. Arecanut, cashew and cacao are the other plantation crops specially in Kerala in India and it appears that no practical solutions have been found or applied so far in these cases as is unfortunately the situation also with coconut.

The above observations made by Pillai are fully substantiated when you see the information compiled by All India Co-ordinated Research Project (AICRP) in three of their publications on the subject (AICRP-1989, 1993 and AICRP 1994)

Soybean

Soybean has been an important cash crop in the Americas and since last 1-2 decades also in Asia, including India. The major insect pests of soybean are defoliators, specially the velvet bean or soybean caterpillar *Anticarsia* sp. and a number of other pentatomids, which feed on pods and seeds.[65] Both of these are quite widely distributed apart from foliar diseases which includes Cercospora and a few other soil-borne fungi in addition to several weeds.

In Brazil, cultural controls developed include the use of early maturing varieties to escape pentatomids, early planting to avoid thrips which are vectors of virus disease, use of trap crops and soil management. Use has been made of varieties

resistant to nematodes. Some 8 biological control products are recommended including NPV used against velvetbean caterpillar. The various methods are being employed as a means for non- pesticidal control of pests and some of the technologies in use in Brazil etc., may well be adaptable to this country.

Groundnut

This is an important crop in Gujarat as also in Andhra Pradesh and the pest of importance in Andhra Pradesh is *Spodoptera litura* which defoliates groundnut crops affecting some 80,000 Sq.Km coastal strip of eastern India. Although this pest was earlier considered to be a pest of tobacco only, but now it is a serious pest of groundnuts also. *Spodoptera* also attacks chilli, another important cash crop in the Guntur District of Andhra Pradesh , ICRISAT, ICAR and Agriculture College, Baptala in Andhra Pradesh have jointly worked out an innovative and successful IPM field programme with the active involvement of farmers, which is now being considered a success story. As is now becoming clear, there were no outbreaks of *Spodoptera* on farms not using pesticides.

One IPM method worked out entails the adoption of clean cultivation practices in order to fully expose the pest pupae to contact with natural enemies. These include use of pheromone traps, growing sunflower and castor plants as trap crops around the fields and the mass mechanical collection of larvae and egg masses from trap plants. Sunflower was found to be far more successful as also the application of fungicide twice and one of neem kernel extract and an application of necessary of the NPV spray. The above method has also been used successfully for chillies with minor changes. It has also been observed that the use of high levels of chemical nitrogen fertilizer increased insect damage in chilli crops. The presence of birds and predators such as ladybird species were found to help considerably in controlling the pest. Recourse is also made to use of varieties resistant to jassids and thrips.

Mixed cropping and inter cropping for which over 811 crops are used the world over, offer considerable help in pest control, as also the increased parasitoids and predators population.

Heliothis armigera has turned out to be an important polyphagous pest of several crops feeding on some 181 species of host plants, including weeds spread over a large area during

most time of the year. *Heliothis* outbreak has its origin largely on account of changes in cropping patterns adopted by the farmers. For instance sunflower has become a popular crop in Maharashtra, providing pests an acceptable host. Many farmers are cultivating groundnuts around the year.

It is for these reasons that a clear cropping sequence is laid down. There is reason to control and to develop a cropping pattern to ensure a break in the availability of an alternate host habitat for the pests. Likewise many commonly found weeds such as *Lagesca malis* in one study has been shown to harbour 22,40,000 larvae of *Heliothis* per ha. For instance *Vicia sativa* weed has been found to be preferred by female of the pest and its removal reduced pod damage by 36-75 per cent. Datura metal, *Acanthospermum* sp. and Gynadiopsis sp. are some other important weeds for *Helio this sp*. Intercropping of chickpea with mustard, barley, wheat, linseed, coriander amongst others has been found to reduce damage considerably as compared to Chickpea alone.

In cotton also crops like cowpea, groundnut, soybean, clusterbean, setaria and greengram have been found to help control of *Helio this* which also enhances presence of beneficial spiders, chryosopids and coccinelids.

If pigeonpea is taken as an intercrop with cotton, as in Maharashtra, it serves to help the migration of Heliothis causing serious damage, since this pest is common to both these crops. However, if indigenous (desi) cotton varieties are grown instead, the damage from *Heliothis* is considerably reduced.

The use of resistant varieties, several of which are available help control of *Heliothis* in case of both cotton and pigeonpea. Similarly the mechanical collection of *Heliothis* helps in reducing the pest load on the crop. The collected larvae is being utilised for the production of NPV for use against the *Heliothis* on the crop.

Mention has already been made of success of *Trichogramma* sp. and *Chrysoperloa* as a part of a strategy in managing this pest. In addition natural processes also help as for example during February when the cotton fields are ploughed, one can see a stream of birds following the opened furrows to pick up the exposed insects, thereby reducing pest population. Many small birds also appear to pick up the larvae. There are many predatory birds including the black drongo (*Dicrurus* sp.)

apart from blue jays (*Coracias* sp.). *Sturmus roseus* the rosy pastor, *Merops orientalis*, the greenbee eater amongst others. Reference has also been made to the use of light traps to attract unwanted insects although some reports suggest caution since possibly these may also attract beneficial insects. [66-70]

POTATO

Potato is an important commodity world-wide and is grown in most countries. Russia is perhaps the largest producer of potato, followed by Poland, USA, China and India. Potato originated in South America and the Spaniards introduced it in Europe in the mid 1500s. About the same time the English explorers brought it to England and from there it moved to Ireland and Scotland and became the principal crop in Ireland with a large population depending on it for food. From 1845-47 the Irelands potato crop failed because of late blight and some 750,000 Irish died of starvation or disease. Hundreds of thousands of Irish emigrated mainly to USA.

As per RAFI,Canada, a new and more virulent form of late blight fungus (*Phytopthora infestans*) is now threatening potato crops around the world. This late blight fungus is believed to have originated in Mexico.[71,72]

In Central South America it is generally grown in combination with other vegetables, maize and grassland for dairy cattle. Key pests are two species of tuberworms, *Scrobipalpopsis* sp. and *Phthorimaea* sp. Other important pests include early and late potato blights, nematodes, white grubs, leaf hoppers agromyzed leaf miners, potato aphids and whitefly (*Bemisia* sp.). Potato pests in the Americas are generally controlled by pesticides although some aspects of IPM are in use, such as rotation with vegetable crops and allowing use of dairy cattle to graze on crop fields after harvesting to make use of cropresidues including weeds.

India produced 15.25 million tons of potato (1990-91) but the extent of pest damage is not clear. However, as per AICRP report, for control of potato tuber moth, parasitoid Trichogramma chilonis was able to create parasitisation of 2.5-75 per cent upto 3 metres. Instead of T. chilonis, releases of *Copidosoma* sp. and *Chelonus* sp. were found to be superior to endosulphan at trials undertaken at Pune keeping the tuber moth attack under control.[73]

Reports from Minnesota show that over-irrigation helped the *Verticillium* wilt fungus growth lowering potato growth. In another study, increased levels of Colorado potato beetle

(*Leptinotarsa* sp.) led to an increase in yield loss from early blight disease caused by *Alternaria* sp.[74]

In aphids that spread pathogens such as potato leaf roll virus (PLRV) and potato virus-Y (PVY) transmission occurred throughout the potato growing season even in the absence of green peach aphid (GAP) which was generally thought to be the only important aphid vector of PLRV in Oregon studies. It seem virus transmission can be stopped with aphid control. Wisconsin farmers have succeeded in marketing organic potatoes. Weed control was achieved by cultivation of pigweed etc. Other strategies of disease management were mainly through use of plant resistance. Soil-borne pathogens were controlled by crop rotation. Use was also made of early maturing varieties to overcome Colorado potato beetle (CPB) and potato leafhopper (PLH). Bt application controlled most first generation pests It was found that natural enemy activity increased in organic fields. Populations of beneficial arthropods such as ladybird beetle and lacewing larvae spiders also increased.

Cassava (Tapioca)

Cassava, a starchy food crop feeds about 500 million people in the tropics and is mostly grown by the poorest of the poor cassava roots is the staple food of some 200 millions in Africa.[75,76] In many countries cassava leaves, rich in protein are also eaten. It was brought to Africa by the Portuguese some 400 years ago. Cassava mealybug (CB) and green spider mite (GSM) were brought accidentally to Congo in Africa from South America in the 1970s and has spread all over causing losses upto 80 per cent crop losses estimated at US$2 billion a year. Mealybug which is the more dangerous of the 2 pests, has a waxy covering which helps it to repel pesticides.

Years of investigations led to the discovery in 1981 of a predator wasp *Epidinocarsis lopezi* in Paraguay which preys on mealybugs. This wasp has been multiplied and released in several African countries with considerable success. Some 38 countries are affected by the mealybug. Forty per cent of the world cassava is grown in Africa, more than now found in its native Latin America. As a source of calories it is the 4th most important crop in the tropics, after rice, sugar and maize.

Cassava is affected by other pests such as whiteflies, cassava hornworm, grasshoppers, storage pests and root rot and virus infections. Green mites are being controlled in Africa

through phytosid mites – natural enemies again from South America. A fungus disease of green mites in tropical America is another potential natural enemy for use in Africa and has been identified in Brazil, which is one of the worlds largest cassava producer. A new granulosis virus that infects the hornworm has also been developed. This would help on some 2 million ha helping to control some 60-100 per cent of this major pest.

A New Cassava (Tapioca) Pest Reports from CTCRI indicate incidence of an epidemic caused by a new whitefly. *Aleurodicus dispersus* Russell which attacked tapioca crop during November 1993 - April, 1994.[77] Nymphs congregate on the lower surface of leaves secreting large quantities of white-wax. The pest also infests and breeds on annona, banana, okra, egg plant, Cassia, calophylum, citrus, chilies, coconut, fig, guava, hibiscus, jasmine, leucinia, mango, *Ocimum sanctum, O. basilicum*, rose and sapota. The grubs and adults of coccinelid beetles (*Menochilus* sp. and *Scymnus* sp.) prey on the whiteflys' nymphs and pupae.

Ber

White grubs have a preference for 'ber' trees and the beetles can be light- trapped and destroyed by putting in kerosinised water or beetles may also be collected through jerking the plants.[78]

Tobacco

Tobacco is an important commercial crop in many countries notably in the USA. In India exports of tobacco products fetch about Rs.500 - crores in foreign exchange apart from excise revenue of Rs.3000- crores annually. So important is the crop that the ICAR had created the Central Tobacco Research Institute at Rajahmundry, Andhra Pradesh which is itself an important tobacco growing state. Many insect pests attack tobacco from the time of sowing onwards. Tobacco Caterpiller, *Spodotera litura* is the most important of all pests and affects nurseries as well as field crops.[79]

Castor is used as a cover crop/trap crop for *S. litura* F and helps in the management of this pest. Thus the ideal non-pesticidal approach for control of *Spodoptera* alongwith neem, natural enemies and NPV, which has been found to be highly effective, is *Telenomus* remus an egg parasite which are compatible with seed suspension and has been found to be very

effective. Yet another larval parasite is *Apanteles*, a larval parasite which has also been found to be a useful ally as also NPV of *S.litura* F and neem seed suspension. The cost-benefit ratio for IPM was 1:2.74 and for conventional control it was 1:1.52

Incidentally of the world tobacco production of 6,879,000 tons, India was the 8th at 2,628,000 tons or 6.5 per cent of world production.[80]

Millet

In the Sahel region of Africa millet has been the traditional staple diet and is grown either in pure stands or mixed with crops like sorghum and cowpea. In West Africa millet is grown as a rainfed crop often in rotation with groundnuts or maize. Major pests in the Sahel include grass hoppers, millet earhead caterpillar, *Rhaguva* sp. stemborers, *Sesamia* sp. and meloid beetles, Downy mildew and millet smut and a variety of weeds, most importantly *Striga*.

The farmers have traditionally been using smoke to repel blister beetles and hand weeding and rogueing to control downy mildew. *Striga* weed in sought to be controlled through bush fallow rotations and organic manuring.[81] *Striga* sp. weeds are parasitic in nature and affect cereals and cowpeas particularly in Africa and India. These are particularly in sharp evidence in low-input farming and can cause not only severe infestations but total crop failure. In addition the land may become unusable for susceptible crops. While no single, reliable and effective method of control is available, there are management methodologies which, if integrated into crop husbandry, can curtail the damage.

The crops are grown by subsistence farmers and pesticides are usually provided free. Unfortunately despite a great potential and pressing need for IPM, the preoccupation with locusts apart from other reasons has not favoured deeper development of IPM strategies.

While these factors do not exist in countries, particularly India, unfortunately there is no evidence of any noticeable IPM programme on millets, maize and wheat. In fact in case of rice also the main IPM programme has been initiated by the FAO as a part of its Inter-country programme in Asia.

Weed Control

Considerable success has been achieved in weed control in India especially on water hyacinth in Karnataka, Kerala, Gorakhpur region in Uttar Pradesh as also in Assam. The success rate has been 80-95 per cent with exotic weevils *Neochetina* sp. The insects travel through considerable distances. Another exotic mite *Orthogalumna* has also been established in several tanks. For control of another aquatic weed Salvinia in Kerala and Karnataka, an exotic weed *Cyrotobagous* sp. has been established suppressing *Salvinia* sp. in rice fields.[82,83]

For control of terrestrial Lantana sp. weed, *Teleonemia* sp. has been successful in some areas. A Sri Lankan strain of *Pareuchaetes* sp. introduced for biological control of *Chromolaena* sp. has been found to be superior to the Trinidad strain. To control another common weed *Parthenium*, an exotic beetle *Zygogramma* sp. has been found to be effective in defoliating the weed in Bangalore area as also in Kerala.[84,85,86] The historical background to the origin of many of the common weeds including the country of origin have been brought out effectively by R.D. Gautam of IARI, New Delhi as also the gaping holes in our R&D on the subject.[87]

A recent report from Denmark indicates that the use of certain herbicides in fact promote mildew and greenfly, necessitating the use of other fungicides and insecticides. The trials covered isoproturon (herbicide) and growth regulator ethephon. This is not unexpected and is in line with after-effects of use of various pesticides. Losses in crop yields on account of weeds are staggering–almost 155 billion tons in cereals alone. Average global loss is estimated at 10.6 per cent in rice, 13 per cent in maize, 98 per cent in wheat; losses in sugarcane were 15.1 per cent and 5.8 per cent in cotton. In rice, IRRI, has estimated the loss to range from 10-50 per cent in transplanted rice and from 50-90 per cent on upland fields.

A large number of natural enemies have been introduced in India for the control of important weeds. Several of the important weeds have entered the country along with wheat imports. *Lantana* sp. for instance was introduced in India as an ornamental plant in 1809 from Central America. It is one of the ten worst weeds in the world. It has been reported as a symptomless carrier of scandal spike disease in India.

In the UK, to overcome weeds specially on highways and

paved areas, where use of chemical pesticides has been found to be particularly unacceptable, a weed ripper has been developed. This is believed to be fast acting, versatile and environmentally friendly. The ripper is generally accompanied by a mechanical sweeper to leave the area clean and tidy. It can be easily attached to a tractor.[88]

Yet another highly successful chemical-free weed control system has been developed in New Zealand, the Waipuna system. This is designed to deliver superheated water at precise points, not unlike spray equipment. At present this system is targeted for use by local authorities, non-agricultural agencies, in orchards and vine-yards. It is claimed to be quite effective. Parallel trials conducted show this hot water system to be as effective as the use of glyphosphate - in fact the initial kill with the Waipuna system was faster; this was immediate as against 7-10 days using glyphosphate. Yet another advantage is that the hot water method can be used, even during adverse weather conditions including wind and rain.

The local authorities in UK are now pioneering efforts for weed control and ground maintenance schemes use-based on alternatives to pesticides strategies and Brighton Borough Council is leading the way in this matter. Brighton is in fact following the lead given by Denmark and California in this sphere aimed at Zero or low pesticide use techniques.

The hot water treatment method from Waipuna, New Zealand has spread to Australia, New Zealand, UK, USA as also to Germany and Israel. This technology for instance is being used by the National Trust in UK who manage the amenity lands–such as Modern Hall Park, an important urban conservation Center in South London–without use of any pesticides. Some very limited quantities of glyphosphate are used initially to control knotweed which is a sun lover. It is therefore planned to cover the Park fully with trees. A good deal of bark or wood chip mulch is laid around the saplings. Weeds from the bases of young trees are removed manually with help from volunteers and staff.

At Brighton for instance, use is being made of the companion planting concept whereby Felicia, a host plant of the Hoverfly which feed on Blackfly are planted along with Dahlias thereby reducing the use of pesticides. Use of 13 common pesticides has already been phased out and 13 more pesticides are at present under review.

Similar developments are underway in turf management. For instance the use of chlordane to control earthworms was banned in UK in 1992. The most widely used pesticides are lindane (gamma HCH), 2, 4-D and carbaryl. New technology called the Thermo Lignum process using heat to destroy pests has also been developed in Germany and transferred to UK. It is designed for use in wood, textile, books and papers. [89-93]

IPM has also been successfully employed by the US National Park service covering some 90 million acres of land. Successful integrated use has been made of physical, mechanical, cultural and biological treatments as well as educational methods and tactics to keep out pest damage.

US-EPA has also started a special review of 3 of the most widely used triazine herbicides-atropine, cyanazine and simazine. A similar review has been initiated in UK on pentachlorophenol (PCP) which is commonly used for leather, wood and textiles. PCP, since banned in India, has been implicated in various health hazards. This includes adverse effects on the immune system, it is also foetotoxic causing anxiety, nausea etc.

In Denmark local authorities have been like-wise active in adopting organic methods of weed control. Bark, chips or mulch is commonly used as a cover to restrict light from top soil. Sand and gravel or plant sheets are also used. Extensive use is being made of cover crops which impede weed growth. Flax, senadella and tansy-leaf phacelia are commonly used in UK. Perennial weed cover and shading from shrubs and trees help. Other methods include thermal or flame treatment. In addition recourse is taken to the use of mechanical implements, manual weeding and composting to control weeds.

Dry rot of building timber caused by *Serpula lacrymans*, a fungus in temperate climates, has attracted the widespread and excessive use of pesticides. The method now being used is one of environmental control keeping low moisture levels and preventing high humidity by increasing ventilation. Instead of highly toxic preservatives, use is being made of non-toxic boron compounds. Use is also being made of heat treatment to control the fungus mycelia (1-6 hours at 40° C). It has also been found that sporulating organisms such as *Trichoderma*, with origin in Nepal in the Himalayas, antagonises the causative agent, *S. lacrymans*.

Locust Control

Locusts are major pests on many continents seriously endanger-

ing human food security. It is not only locusts but also migratory grasshoppers too which need to be controlled. In fact there has been concern about the over-focus on desert locusts considering that grasshoppers were just as serious a problem. In fact grasshoppers which are short horned locusts cause damage on a recurrent, seasonal basis without the overwhelming and pressing crisis created by locust swarms.

The recent locust plague in Africa lasted from 1985 to 1989 necessitating massive pesticide spraying in African countries, involving an outlay of US$275 million. In 1988 alone, some 10 million ha in northwest and west Africa were sprayed with some 13 million liters of pesticides. Such massive overhead sprays of aldrin, DDT and lindane as well as carbamates like Carbaryl and organophosphates like malathion led to considerable controversy. This was particularly so because after the locusts were over, annual food losses from pest remained as high as 35 per cent. But the dread of locusts is great especially when you consider that 1/2 million desert locusts, which is only a small part of an average swarm weigh about one ton and devour as much food as 2,500 people eat in a day. The swarms contain billions of locusts and can travel about a 1000 Km. a week.[94]

The oriental migratory locust (OML) occurs in east and south China, South East Asia and the Philippines. They start off with eating grasses and later devour beans and bamboos. In China during 716 AD period, they used fire to drive locusts into ditches and about 50 million Kg. of locusts were killed in Shandong Province. This method was used again in 1944 killing 9 million Kg. of locusts. Special ditches are built and fires burnt at night to attract locusts to light. Other physical methods were also used. In 948 AD, China started protecting locust eating birds.

In 1597 ducks were used in paddy fields to control locusts successfully. Each duck is estimated to eat about 1 Kg locusts(nymphs) per day. Sometimes chickens are also used for this purpose. Frogs have been found useful as also a parasitic fly, *Blaesoxipha lineata*, which parasitises about 70 per cent of adult locusts, sometimes reaching a figure of 100 per cent kill.

The microspora, *Nosema locustae*, a natural enemy of locusts in Africa, was introduced by a US scientist in 1985. There is now a factory in Beijing which produces sufficient microspora to cover about 133,000 ha of grasslands annually.

The emphasis has been on water management, cultural

controls, agroforestry and chemical control, the last of which is being increasingly restricted. One perennially affected 50,000 ha area in the Hongze Lake shore region of Sihong county in the 1950s has been reclaimed by multicropping and planting more of cotton, rape, tobacco, peanut and fibres, sweet potatoes, sesame and green maize. These are the crops that locusts don't like to eat.

There has been, as a consequence a steep fall in the presence of locusts and instead insects such as plant hoppers had re-appeared as also cotton pests and cutworms indicating that effective locust control and really needs control, IPM.

The natural enemy population parasitoid wasp, Scelio uvaron, which for example parasitised 5 to30 per cent of the eggs in 1950s increased by 1979 to 50 to 80 per cent. Frogs, spiders and birds had also increased. [95-96]

However, the situation elsewhere including Africa, mid-east and India continues to cause concern if we are to go by the locust invasions in this region during 1994. In 1986 some US$40 millions was spent to control locusts that threatened some 3 per cent of crop production in nine affected African countries. These efforts saved crops worth US$46 millions which represented 3/5th of the threatened crops but only 2 per cent of total crop production. CABI in the UK have demonstrated that it may be feasible to use fungal pathogens such as *Metarhizium* sp. and *Beauvaria* sp. for locust control. Trials are also under way on pheromones and anti-feedants. However, much hope is being placed on the successful use of fungal agents in view of not only prohibitive costs but the large geographical area involved. The problems in the Red Sea Area which concern this country should spur R&D in this area of serious concern.

However, when the question of the problem of locust management came up in the Parliament pointing out the promising directions in which China was moving and the new R&D efforts in the UK as a possible environmentally sound locust thinking, the Government as usual hedged giving vague evasive replies without revealing what was being done on the subject in the country much less elsewhere and whether the Government had any plans apart the use of pesticides or setting up a remote sensing Laboratory to improve locust surveillance and forecasting infrastructure.[97]

Coffee

Coffee arabica is perhaps the single most important cash crop in Kenya accounting for 29 per cent of country's' export earnings. Lack of disease and pest control has been taking its toll. The use of copper fungicide has been found to be either too little or too late in the case of coffee berry disease and leaf rust. Some farmers on the other hand apply 2-3 times more of broad spectrum insecticides than recommended, quite often destroying natural enemies and aggravating pest problems.[98]

In addition there is inadequate weed control unavailability of disease-resistant coffee seedlings and other economic constraints, complicated by a drop in the prices of coffee. The plantation is attacked by a large number of insect pests--ranging from leaf miners to lace-bugs which fortunately are kept under check by a host of indigenous natural enemies particularly parasitic wasps and predators such as lady bird beetle species. In the 1950s an exotic parasite (*Anagurus* sp.) was introduced from Uganda against the Kenya mealybug, *Planococcus kenyae*, which has generally kept this pest under control.

IPM system here relies on pruning in order to prevent antestia bug from hiding in leaf clusters. Mulching is used to prevent the larvae from reaching the soil for pupalation. Unfortunately the leaf miner, green and brown scale and mealybug species produce sweet exudates on which ants feed and these ants in the process interfere with the working of coccinelid beetles which ordinarily serve as biological control agents. Thus the lower trunk of coffee plants are treated with insecticide to keep off these ants in order to help the beetles to operate. For control of helmet scale and white waxy scale, the severely infested branches are cut off and allowed to remain on the ground in order to promote emergence of parasitoids.

Furadan and Ternik Disyston–all systemic insecticides are used for control of sucking and mining insects by the larger farmers–keeping in mind the need to safeguard beneficial insects populations.

A number of diseases are known of which coffee berry disease (CBD) is the most serious, at higher altitudes. Coffee leaf rust (CLR) a serious leaf disease, which is caused by the fungus *Hemileia vastatrix* a serious leaf disease leads to premature fall of leaf and reduction in flower numbers. There is also the

bacterial blight and fusarium bark disease. These are sought to be controlled by pruning, through host plant resistance and also through chemical. As is generally the case with IPM, the entire system is to be so planned as to meet the needs of the situation so that the use of pesticides is minimised and the crop protected to the maximum extent. As in many other similar situations there is clear evidence that the use of insecticides invite cyclics outbreaks of insect pests – in this case particularly of leafminer. Further the use of these chemicals interferes with natural biological control species.

Sometimes spot spraying with pesticides has resulted in outbreaks of cottony scales and fried egg scales. In such a situation the mass release of predatory ladybird beetles has been found to help. Even the use of spray of a mild detergent like Teepol against scale attack, was found to attract ladybird beetles which in turn controlled the fried egg scales.

Need for intensive R&D is clear when one sees that copper compounds which have been used for over 25 years in coffee, now appear to be helping spores of some CBD strains germinate faster. This apart sprinkler irrigation, much in fashion in India now, itself seems to increase CBD. The Indian Coffee Board and UPASI which are both located in Kerala where bulk of the coffee grows, do not appear to have yet caught up with the introduction of biological control despite the frantic demand of organic Coffee in the affluent west. Since coffee comes under a commodity Board which is attached to the Ministry of Commerce, it seems the ICAR and the Agricultural Universities supported by it, have left out commodities like coffee and tea to the vagaries of nature and the national one crop commodity Boards. Possibly it is high time to unify and bring all R&D in operation under one umbrella of the Department of Science and Technology as is the case in Australia under a unified Council of Scientific Research Organization (CSIRO). But who will bell the cat with such varied and diverse vested interests operating, aimed at self-interest as against the need for fulfilling national interests. Perhaps policy and decision-makers may see the directions, demand and market for organic coffee which brought together over 300 producers, traders and R&D from 16 countries on the subject in 1994 at Chiapas, Mexico.[99,100]

An example of successful integrated pest management in coffee comes from Chiapas, Mexico for a new medfly management which were discovered in March 1992. This

arose from the farmers sad experience with aerial spraying of malathion. In this case 31,000 L of 95 per cent malathion was to be sprayed. Farmers got together taking the help from indigenous organic Coffee Cooperative and organic specialists from California and local Government to stop the planned spray and this effort worked. Instead a program for release of 500,000 medfly natural enemies weekly, enemy conservation methods, release of sterile male flies and the baiting of male flies with pheromone traps with botanical insecticides was undertaken with success. The technique of a wasp to control Coffee Broca was already in use by the organic farmer. As it is malathion aerial spraying apart from being costly, had also resulted in resistance in pests active in the coffee crop.

Cocoa

Like coffee, cocoa is an important small-scale cash crop of equatorial West Africa although it is being increasingly grown in South-East Asia, including India by small-and-large commercial plantations. It is also found in the Caribbean and parts of Central and South America. It is commonly grown under shade with oil palm, coconuts and other food and cash crops.[101]

The major cocoa pests include rodent and insects, notably Miridae in Africa as well as South-East Asia and a pod borer and stem borers. Disease like Phytophthora, VSD and cocoa swollen shoot virus also are present. Weeds are also important initially but not after a good canopy formation.

In South-East Asia plantations a range of methods are used which include cultural and harvesting against *Canopomorpha* sp.(pod borer) and *Xyloborus* sp.(stem borer) and shade management against mirids. Pruning and uprooting is also practiced in disease control apart from mechanical controls and removal of infected pods-methods which are also used in Coffee plantations.

The use of ants against mirids is believed to have been developed in Indonesia during the thirties and is now again been re-discovered both in Indonesia and Malaysia. The IPM also involves the minimal use of pesticides both in South East Asia and West Africa. For cocoa host plant resistance is not of much help at present. As in the case of coffee, the IPM system and alternatives to pesticides has not received serious and in-depth attention despite its' obvious benefits, including fulfilling the consumer demand for organics. There is no record of, or access to any work which may have been done in India for development

of organic coffee or cocoa although there are reports of sizable exports of organic tea from South India obviously to get better economic returns. But no such product is yet on the market in the country.

Garlic extracts have been reported to be successful against *Lymnaea acuminata*, which proved to be better than the synthetic molluscicides like phorate and carbaryl. More recently D.K. Singh and A.K. Singh have reported that neem-based products significantly caused reduction in fecundity, hatchability and survival of the young snail, of the above species, which is the intermediate host of liver flukes, *Fascola hepatica* and *Fasciola gigantica*. The snail breeds all the year round and lays eggs on lower surface of aquatic plants.[102,103]

Ants

While on the subject of ants, a reference may be made to the night raiding leaf cutter ants which are rated as the worst pest for cattle ranchers in the Savannas of Brazil, Colombia, Venezuela and Bolivia in Central America. The Ciat scientists at Cali, Colombia have met the problem by identifying 3 ant-proof grass varieties that stop ant attacks without the use of pesticides. These ants can remove almost 5 metric tons of grass from 1 ha. in a year's time. Actually the ants don't eat the grass, they just snip off and carry leaf bits to their nest where they feed a fungus which grows only in the leafcutter ant nests. The fungus is the main food for raising their young. In 3-4 years the *Acromymex* sp. ants can destroy an established pasture.[104]

There may be about 60 million ants in a 1 ha. of pasture and the use of pesticide is both costly and difficult. These ants died off when 3 ant proof grass species of Brachiaria sp. were planted. Ciat scientists are at work trying to identify the element(s) in grasses that inhibit fungus growth. Hopefully such information can open up new vistas to meet such situations in the future. Incidentally the Savannas in Central America, four times the size of say France, produce over US$15 billion worth of meat and milk annually.

Pasture Lands

Apart from the peculiar problem of leaf cutter ants in the Savannas of Central America in Costa Rica and other countries, spittle bugs have been major problem of pasture lands, making the forage unpalatable and even poisonous to the cattle. To add to the problem the weakened infested plants give yield

to the weeds, such as Sida, Bideus, Lantana and Rotboelia.Using a fungus *Mucor* sp. on the spittle bugs has achieved success.[105]

Fruit Trees

In Chile the larvae of fruit tree weevil (*Naupactus* sp.) which damage the roots of grapes and many other fruit trees could not be controlled with chemical pesticides. Use was made by creating a barrier of an insecticide painted on a polythene strip wrapped round the tree (grapes) trunk. Likewise grape mealybug was controlled using a minute wasp parasitoid (*Pseudaphycus sp.*) Similarly European grape thrip *Drepanothrips* sp. and bunch rot pest, *Botrytis* sp. could be controlled using phytoseid mite as a natural enemy. Such enemies are also used in respect of European fruit lecanium scale.[106]

Rastrococcus sp. predators are being released to control mealybug. *C.montrouzieri*, *Leptomastix* sp. and *Coccidoxenoides* sp. have also been identified to control mealybug in Pomegranates.

The mealybug, *R.invadeus* was first recorded against mango in Africa in 1981. Another mango mealybug *Gyronussoidea tebygi* is reported from Togo. The Mealybug of mango has been controlled in India through release of coccinellid predator.

In India use of *Aphytis proclia* and *Encarsia perniciosi* against San Jose scale has been used in apples in Kashmir. Chilocorus bijugus, the predator, when released reduced the San Jose scale density in Kashmir and its release in Solan also had a similar effect.[107]

Likewise parasitoid *Aphelinus mali*, has been released in Nauni and has led to control of woolly aphid in apple.

A nematode *Heterorhabditis bacteriophora* developed at Solan has been found to control the white grub, *Holotrichia* sp., *Aphelinus* sp., *Aphidius* sp. and *Signiphora* sp. also appear to be promising on pomegranate aphid in Bangalore area. Likewise efficacy of natural enemies on guava and grape mealybugs in Bangalore area has been found to be successful.

Ornamental Trees

World-wide there is concern over dwindling forests including ornamental trees- due to mans' destructive instincts. As we will see these tendencies are further intensified by pests. Work done at the Kerala Forest Research Institute, Peechi, Kerala,

during 1991 for finding enemies of 2 well known insect pests of Teak (*Tectona grandis*, Linn and *Hyblaea puera*) which are known commonly as Teak Defoliators against which NPV was active. Likewise trials using Bt also appeared to show potential effect of NPV in the field. Two fungal pathogens also showed potential for control of *E.narcissus*. There are a few other promising candidates as biological control agents under investigation. [108]

Gypsy moth (*Lymantria dispar*) a major forest pest is responsible for timber losses of US$266 million in Pennsylvania State in USA. The black vine weevil *Otiorynchus*, feeds on foliage, flowers, fruits and roots of a wide variety of herbaceous and woody ornamental plants in US, Canada and Europe. The weevil also feeds on grape-vines.[109]

In the case of Rhododendron a tree of importance found in the Himalayas, a significant pest is *O.ovatus,* the strawberry root weevil. As in other IPM strategies, in this case also, monitoring is of importance. Yet another important step is the use of weevil resistant varieties where possible. Use of mulch around the shrubs is recommended to decrease weevil incidence as also use of sticky barriers to the trunks of susceptible plants. Successful use has been made of 2 nematode sp. to destroy weevils at the grub stage. If necessary sparing use is also made of acephate.

Destruction of trees and flooding caused by beavers (*Castor canadensis*) in the north east USA and some of the southern and northern States has been causing havoc leading to flooding of agricultural and forest lands and damage to roads and railroads as beavers impound water to make increasingly marginal sites suitable. Beaver repellents, on the concept of pheromones, have been tried successfully. These are made from castoreum from the Eurasian beaver; castor fiber and anal glands from male and female beavers, suitably blended to mimic the odour of mated beaver pairs and applied to artificial mounds on the waters' edge. [110]

To control *Heliothis* sp., betulin derived from the bark of paper birch (*Betula papyrifera and B. populifera*) has been successfully developed in the USA. This serves as an anti-feedant against green peach aphid although it did not work against several other pests like spruce budworm, Colorado potato beetle, bollworm and armyworm. There are also reports of the development of Avermectins- a group of compounds- by the pharmaceu-

tical giant Merck from an actinomycete, *Streptomyces avermitilis* which appears to have a very wide ranging broad spectrum activity ranging from animal parasites, tobacco budworm, cotton bollworm, to a wide range of mite and insect species with a low toxicity for beneficial oragnisms.[111]

Abamectins have also been effective in control of leafminers, a major pest of chrysanthemums which in California State of USA alone caused an estimated damage of US$93 millions spread over 4 years. A number of household pests such as cockroaches, houseflies and clothes moths, are claimed to be controlled effectively. There is however a need for caution in interpretation of such claims as these quite often turn out to be premature as has happened for instance in the case of pyrethroids.

Reverting back to forests and shade trees, Commonwealth Agricultural Bureaux International (CABI) which had a pioneering Laboratory unit at Bangalore with international linkages for a very long time and had done major notable work especially in the area of biological control agents has since been closed down by the Government. However some of the work covered the control of the larch sawfly in Canada through the release of 2 parasites. Similar successes had been achieved with the European pine saw fly through release of 8 parasites in Canada and control of larch caserbearer in Eastern USA through the release of two parasites. European winter moth which appeared in Nova Scotia, USA was also effectively controlled through the release of parasites. Substantial control was also achieved in New Zealand through control of oak leaf miner by the release of another two parasites. At least two parasites from India were also used in Trinidad and Florida and one from Jamaica in Bermuda. This exercise of import and export of parasites and predators in a wide variety of pest diseases paved the way for a highly successful international scientific interaction and mutual give and take.[112,113,144] Perhaps the termination of this link was an unfortunate decision which terminated the obvious advantages for mutual benefit. The CABI for instance had successfully introduced 2 parasites for sugarcane pests from Colombia and other countries way back in 1963.

A number of serious diseases of forest and shade trees in USA, specially Douglas fir and white fir and Eucalyptus affected by different diseases and pests were for instance amenable to some remedies. For instance elm leaf beetle was controlled by use of Abamectin or Bt or *Bacillus popilliae.*

Use of trap trees has also been found successful. Yellow sticky traps consisting of split panels with pheromones have also been used effectively. These control engraver beetles, gypsy moths and some other forest pests. A unique cuticular fungus has also been isolated which infects Japanese beetle larvae. Other promising natural enemies used are Serratia bacterial sp. and some nematodes which provide upto 95 per cent reduction in Japanese beetles. A floral line is being used to lure adult Japanese beetles and these are more susceptible to beetles than fungi against larvae.[115]

Gypcheck a new NPV has been developed to control gypsy moth a major forest pest against timber, accounting for an annual loss of some US$266 millions in Pennsylvania State alone (1991) in trees around homes in the suburbs/rural area. Leaves of the little known tropical member of the mint family (*Salviablanca or Phytis*) found in Mexico's Balson river basin are reputed to act as a potent insect repellent.

Some chitin products such as clandosan are known for their fertilizer and nematicidal properties. Chitin and chitosan inhibit Fusarium sp. and the breakdown products are also effective against fungal growth. Chitosan induces plant chitinase activity which fights several fungi. Monsanto's are also involved in developing insect-resistant cotton varieties. As is known cotton bollworm (*Heliothis zea*) tobacco budworm (*Heliothis virescens*) and *Pectinophora gossypiella* caused nearly 300 US$ million damage in cotton in USA(1991). Tobacco and tomato plants have already been engineered with genes that produce Bt Kurstaki insecticidal protein- levels. Cotton plants have now been engineered with high Btk protein which are resistant to cotton bollworm. Attempts are afoot to develop purified insecticidal protein from Bt. against major insect pests. The results have been promising, although variable.

Sometime in 1950, *Trichogramma* sp. was released, followed by Vedalia beetle for control of cottony cushion scale as also to use of ants as predators. In the 1970s the manual collection of ladybird beetles was organized and used to control aphids and *Heliothis* sp. larvae. Cultural practices were adopted such as inter-planting Soya with rice. By 1970s Trichogramma covered 70,000 ha. However since the 1980s, official support had declined in favour of pesticides.

Yet a 1990 survey shows that 12-15% Chinese farmers continued to use biological control. More recently Government

interest has revived in favour of biological control agents for weeds etc., with help from New Zealand and USA. Perhaps there has been fear for sub-lethal pathogens gaining entry in China through biological control agents from the importing countries which must have weighed with them in slowing down on the biological control systems. With the end of the cold-war, China is thus returning to the path of biological control which augurs well for promoting alternative agriculture.[116]

Vector Control

A number of mosquitoes are known to be vectors especially in tropical lands which are proliferating largely due to stagnant pools which provides breeding places. In urban areas overhead tanks, drains etc. are providing yet many more breeding sites, apart from faulty open sewage disposal systems, some non-existent in some places. Houseflies may carry Trachoma and diarrheal diseases, whereas leishmaniosis is carried by sandflies. Fleas could carry plague, typhus fever.[117] More importantly mosquitoes can carry dengue virus and possibly yellow fever and filaria. This apart Japanese encephalitis and malaria are also carried amongst others by different varieties of mosquito vectors.

According to the Government of India reports, there are over 2 million cases of malaria causing upto 1000 deaths annually. The low figure for deaths seems to be an under-estimate, though. Malaria has reached epidemic levels in many regions of the South. As per WHO, 40 per cent of the world population lives in malaria-infested areas and some 270 million new malaria cases occur each year. A new drug-resistant malarial parasite has emerged in Cambodia which may spread.[118, 119] It now seems clear even to the diehard bureaucrats and technocrats in India that pesticides alone cannot control malaria and they are now talking of using Guppy and Gambusia fishes in ponds and of Artemesia annue, a herbal drug from China. It has been calculated that of the 2 million cases of malaria reported each year, 39 per cent are of the virulent Falciparium malaria (cerebral malaria).[120, 121]

A number of cost effective vector control methods have been developed with varying degrees of success. However, in view of the scare amongst people of the diseases involved, the general tendency has been to go in for chemical pesticide control.

Bt-H-14 and *Bacillus sphaericus* have generally shown promise against many mosquito species. These are used both for vectors and mosquitoes which constitute a nuisance. Several fungi have been shown to be pathogenic to larvae of mosquitoes and other disease vectors. A fungus, *Lagenidium giganetum,* has attracted considerable attention. Similarly, several nematodes have been found to be effective. In addition, use has been made of larvivorous fish in several countries viz., USA, Europe and India.[122]

In Peru where Malaria is endemic, affecting 16 out of every 10,000, *Bt* var. *israelensis* (Bt I) has been successfully used against *Anopheles* sp. A scientist from Lima (Peru) has reportedly developed a simple method for growing of Bt I using coconuts, a local product. Bt I spores are grown in coconut water in the laboratory. In field trials Bt I fermented in coconuts destroyed almost all larvae in various ponds in Peru. The public threshold for nuisance mosquitoes has been laid down by US scientists varying the tolerance level from one bite per 12 minutes to 3 bites per night in the case of nuisance mosquitoes. Neem seed extract has also been suggested as a suitable control system for yellow fever mosquito.[123] Rice fields in Southern India have also been found to be sustaining vectors of Japanese Encephalitis.[124]

Reports from Colombia show that an anti-malaria vaccine has been successfully developed and mass vaccination may help. The vaccine has been developed by a young scientist Dr. Manuel Pattarroyo through analysis of the parasite *Anopheles* sp. surface layer, particle by particle, which he reconstructed biochemically. Initial trials in Colombia in 1988 show that it protected 40 per cent adults and 70 per cent children.[125,126] Trials in Tanzania have proved successful and tests are under way in Gambia and Thailand. Several other remedies are under test including the Chinese, Antemisnin, from the medicinal herb quinhao Spf 66.

However , the real way to meet the problem is prevention of incidence of malaria which can be done provided we can devise ways of vector control through the elimination of breeding places, an area in which biological control agents could serve as an excellent tool. As has been brought out by the FAO, there is first of all a need for environmental management. Biological control is perhaps the best cost-effective tool available.

What is obviously needed was a re-orientation of our

strategies. For instance instead of single vector control programmes, there is need for a combined unified action. A key factor is training and trained manpower. Likewise there is by and large weak support for R&D which alone has the potential to meet the demands and needs of the situation. There is a general feeling that for the success of vector control which means so much for the maintenance of public health vis-à-vis the diseases that these vectors transmit, an essential component would be high level continuous R&D. The last but not the least measure needed is enlistment of community and health education at all levels with the support and backing of other public health authorities. In the present day context active the involvement of voluntary groups would hold a hope in this area.

Tsetse

Tsetse fly is a vector of trypanosomiasis one of the major tropical diseases in Africa causing sleeping sickness, a fatal disease in man. It also causes Nagana in cattle, a major limiting factor in livestock production. Low cost NG 2B traps with different odours have been designed to attract tsetse flies.[127,128] Use of cow urine as an attractant along with traps seems to help. Use of DNA virus, bacteria and entomopathogenic fungi has also been found to be helpful.

Neem-based fractions have also been found to significantly reduce weeding of culicines in rice fields showing high activity against filaria carrying *Culex* sp. and the urban malarial vector, *Anopheles*. The neem preparation did not show any adverse effect on fish Gambusia which is widely found in rice-fields and itself devours the vector.

A reference has been made, generally of IPM work itemwise, at various institutions, states and countries. At some places, instead of crop-wise or item-wise, these examples have been given either country-wise or Institution-wise, for convenience. For these reasons and to draw pointed attention to the work sponsored by the Department of Biotechnology, New Delhi, aimed at enhancement of pest resistance in crops or use of IPM is briefly brought out below.

The Department of Biotechnology (DBT) has pursued this area, concerned about the estimated annual losses varying between 30-90 per cent in stored grains—involving some Rs.10,000 crores. There have been other pitfalls and problems

for instance some 56 per cent of pesticide use in India covers just one crop, cotton, even though it covers an area of only about 5 per cent. Further the small and marginal farmers particularly in hilly areas and arid zones or rainfed areas with very poor yields even though they raise important crops like oilseeds, pulses and coarse grains just can not afford the use of high cost inputs like pesticides.[129-131]

Besides the drylands constitute some 73.5 per cent of the net arable area, contributing about 45 per cent of cereals and 7 per cent of pulses and oilseeds in the country. The DBT initiated its work on biological control of pests, diseases and weeds in 1989. The emphasis was on technology for mass-production of biocontrol agents—NPV of *Heliothis armigera*, *Spodopterea litura*, GV of Chilo infuscatellus, *Trichogrammma*, *Chrysopa* and *Trichoderma*. These were used on 11,000 ha of land in fields of cotton, chickpea, tobacco, sugarcane, groundnut, sunflower, blackgram, greengram, pigeonpea and other pulses, sesamum and cauliflower amongst other crops.[131, 132]

A *Pseudomonas fluorescens* species has been developed as a biopesticide for control of soil-borne and air-borne diseases and were found effective in banana for control of Panama wilt as also in chickpea wilt with incidence of disease in both cases falling from 40-50 per cent to about 4 per cent in field trials. VA Mycorrhiza fungi when applied at the time of planting turmeric and ginger were highly successful in the control of root knot nematode infestation. *Trichoderma* sp. was found to significantly reduce the root-rot in urad bean as also incidence of chickpea root-rot. In pulses *Trichoderma* sp. and B. *subtilis* where highly successful in the control of root-rot without affecting nodulation and were also compatible with *Rhizobium* used for nitrogen fixation.

Similar successes were achieved in the case of control of sesamum and sunflower root-rot. Some 4-5 botanicals were also tried out for antifeedant and insecticidal activity against *H. armigera* and a few other pests and found to be both effective and promising. Many such variations and combinations with pest control agents has been tried out with variable success. A considerable part of the success in biocontrol strategy is ascribed to the successful development of biocontrol pilot plants at Coimbatore and Madurai. Training of trainers, farmers and creation of awareness amongst all concerned, including potential users through farmers mela/field days

etc., has been given special importance in these DBT programmes.

While the DBT has taken steps and initiatives in promoting biological control and other components of IPM, the nodal Ministry of Agriculture with a vast network in the states and in the centre has been working in a rather low key. This is despite a vast R&D setup under ICAR Institutes and the Agricultural. Universities with hundreds of Regional Centres spread over the country, the progress is minimal at the field or even pilot scale level. Generally speaking the thrust is on use of chemical pesticides possibly combinations or dosages. The same is true of the scores of Agricultural Colleges spread over the country several of which continue to be under the control of the traditional universities.

As per the Ministry of Agriculture report for 1993-94, a number of pesticides of plant origin and products were registered but the bottom line is that special initiatives were taken to ensure the supply of quality pesticides to the farmers.[133] For this purpose a National Conference on Pesticides was held on 5.2.1993 at New Delhi by the Department of Agriculture. It is clear from the Report of this National Workshop that this was an opportunity to find ways and means of strengthening of laboratories for testing of pesticides to prevent adulteration. This would explain the agenda and the preponderance of Directors of Agriculture from the states, most if not all of whom are firm believers in indispensability of pesticides, come what may. The Workshop was also full of the pesticide manufacturers and formulators.[134] Barring 2 technical officers, the Agriculture Ministry had a large number of part-icipants from the administrative wing led by the Secretary, Ministry of Agriculture. Likewise Ministries of Petroleum and Natural Gas and of Industry were adequately represented. Matters like Registration, Quality of Pesticides on the market were the main topics apart from implementation of rules regulations under the Insecticides Act. The alternatives to pesticides did not form any part of the workshop nor the trends elsewhere in the world or even in India by NGO groups, for which several seminars/workshops had been organized beginning formation of a group on Alternatives to pesticides *vis-à-vis* consumers by the Department of Science and Technology. This had brought out a landmark report on the subject which had served as the spring board for several important meetings in search of alternatives to pesticides.[132]

In this background it is not surprising that the Directorate of Plant Protection Quarantine and Storage, true to its' traditions and operations should be concerned more about improvement and strengthening of plant quarantine services to provide efficient services to the importers and exporters. However, for IPM technology at the farmers level, says the Report, 26 Central Integrated Pest Management Centres (CIPMCs) carried out pest surveillance and monitoring, promotion of biological control and IPM demonstrations and training to the state extension staff and farmers. This setup has so far covered a sample area of 4.46 lakh ha. by October 1993 and an area of 3.00 lakh ha. had been targeted for rabi season of 1993-94.

For biological control, 26 Centres were promoting biological control methods through the popularisation of conservation of biocontrol agents and also releases of parasites and predators. These centres had mass-reared and released 666 millions of biocontrol agents over an area of 1.71 lakh ha. and also conserved natural biocontrol fauna against castor, cotton, sugarcane, apple, pomegranate, coconut and vegetable crops. During rabi 1993-94, target of 686 million agents over an area of 1.42 lakh ha. had been fixed. The total cropped area in the country is 172.88 million ha, with a very wide range of farmland.

In addition to the above facilities there are some 125 biological control laboratories in different states. In addition some 125 biocontrol laboratories/units are promoting biocontrol method in various states like Pondichery, Andhra Pradesh, Karnataka, Jammu & Kashmir and Tamil Nadu. This apart some of the co-operative sugar factories in Tamil Nadu, Bihar, Uttar Pradesh and Gujarat have their own Biocontrol Laboratories for sugarcane, oilseeds and some other crops. The main activity during 1993-94 of the Ministry of Agriculture, however, it would seem was confined to locust control for which pesticide spray both aerial and on the ground covered some 3,10,255 ha. using a total of 637 tons dust and some 130 kilo litres liquid pesticides. This helped control about 172 mature/immature swarms/swarmlets which entered Rajasthan/Gujurat from the western part of the country.

However, there is no sign of any efforts to undertake any new biocontrol methodologies which are being developed elsewhere nor is there any indication of embarking on any R &D

programmes in this direction. The same seems to be the situation in respect of plant quarantine for which a National Workshop was organized. However, there are wide-spread fears that lack of quarantine and transboundary checks may further lead to the entry of new pests in the country not only from outside but from across the different states in the country. This brings to mind the Irish Potato Famine of 1845 with the entry of late blight pathogen. Also Sri Lanka's coffee output came down from 180 million Kg. in 1870 to 2.2 million Kg. [135]

Looking at the picture across many lands, it does seem that a good beginning has been made to escape from the crippling dangers of pesticides with a large measure of success and if these trends persist, the knowledge gained and the resulting confidence will attract more and more farmers towards the goal of farming without the use of hazardous chemicals. Patricia Matteson and Jet Proost [136] in a recent study of status of IPM in the Netherlands has concluded that the incentives are the key to the success of the IPM and argue for supportive regulations and financial incentives to farmers for ensuring adoption of sustainable agriculture smoothly. IPM has recently also received a shot in the arm in Madagascar following the announcement by its Government of its adoption as an official strategy following a report from USAID.[137]

We have already seen that the controlled comparative studies, carried out by National Research Council in the USA has clearly shown that farming *sans* chemicals, as was the way of the world over millennia, before the advent of pesticides in the forties is indeed feasible and viable. Results of trials conducted in India by the Dutch group referred to earlier bear out the same conclusions. In the following, reference will be made to some other trials from the USA and we shall also go over some of the other farming alternative systems totally devoid of use of agrochemicals. This hopefully will leave no doubt that if we can have an open mind, without the bogey of world hunger, famines and worse, created by the vested interests, that farming without chemicals will emerge not only as a dream but a reality.

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Chapter -10

Technologies That Reduce Pesticide Use

Cows' urine and dung in various forms have been in use over the centuries around the world and is considered to be of help in plant protection. However, the usage has been more of a traditional knowledge and practice relying on indigenous knowledge and experience. Recently researchers at the University of Bonn, Germany, have obtained promising results under controlled trials using compost extracts for the protection of crops. The compost was made from animal manure and cereal straw with top soil and /or old compost. Old compost (8-30 days old) was mixed with water in the proportion of 1:5 - 1:8 and allowed to ferment for 3-7 days. This solution was strained and used as a spray. Various permutations and combinations of raw material were used and the extracts were found to reduce infection level to an average of 55 per cent. The results obtained were reported to be consistent and significant suggesting a safe, economical and effective method for plant protection.[1]

There is also a positive and improved crop response to animal manure and compost as per reports from Senegal conducted under a Rodale project. In yet another study reported by J.C. Obiefuna it was found that the use of compost of poultry, farm yard manure and household waste and wood ash improved plantation growth and greatly reduced nematode infestation and borer infestation. In Central America and Honduras some 50,000 farmers were using velvet bean (*Mucuna* sp.) or fertilizer bean (leguminous) with maize and in the traditional system since 1974. This meant amongst others, low use of pesticides, control of nematodes, low use of external inputs, including seeds and fertilizers. However, in keeping with 'modernity' this method went in disuse but it is back again as reported by CIDICCO. [2]

Some Reduction Strategies

As brought out earlier, adoption of IPM has emerged as a strong basis for pesticide reduction in farm operations as is clear from its wide adoption especially in countries such as USA, which were at one stage in the forefront of the introduction of chemical pesticides. This lead has also helped many other countries, all of which have had the same experience with widespread pesticide application. A stage had now been reached when not only the presence of pesticides in foods, tea or coffee but even in leather goods and textiles is being frowned upon in affluent countries such as Germany. To recall, these are the same countries which had pioneered the discovery and use of these pesticides starting with DDT which brought a Nobel Prize for its German discoverer.

However, despite wide experience and success achieved in reducing or eliminating the use of this group of chemicals for plant protection there continues to be reluctance in many countries particularly amongst the developing countries of the Third World to effectively revert to farming without pesticides or even to revert to IPM. Not surprisingly most of these countries do not have a strong base of R&D which would explain the reluctance even to switch over to less toxic chemicals or plant pesticides. And this is despite the fact that in many of these countries, such as India for instance, 70 per cent, if not more of the farmers are engaged in subsistence farming or marginal farming where they do not use pesticides in any case for a number of reasons the most important of which is the low returns and the costs which are simply not affordable or even possible on account of economic reasons. It is therefore helpful that the lead is now coming from countries such as USA and Germany where there are several strong groups led by official agencies like the National Research Council and the United States Department of Agriculture and several Agricultural Universities and other Institutions engaged in R&D with sustainable agriculture in mind.

In countries like the Philippines and Indonesia where there is already an indication of a switch over to pesticide reduction via IPM after the experience with successive crop failures, the lead as shown earlier has come from the Western scientists/technologists under the banner of FAO and a few other western development agencies.

An example of abandoning the use of malathion for

coffee in Mexico in Central America has been cited as one of the several such success stories. Many more authentic ones have been recorded and reported above. Apart from IPM, are there any other policies or strategies under way, aimed at reducing the pesticide burden, one may legitimately ask. At least three countries in Europe–Denmark, the Netherlands and Sweden have embarked upon specific, well- planned policies aimed at reduction of pesticides. [3]

We have hitherto touched on the necessity of pesticide reduction. It may bear repetition if we reiterate the reasons. There has been a notable effect on biodiversity which in effect means loss of genetic resources especially of the indigenous land races arising from damage, direct poisonings and loss of species, strains and habitat from pesticides. These chemicals have also contributed in no small measure to the pollution and contamination of ecology and the environment including food residues, all involving various degrees of risks for life on earth in its broadest sense. There are other incidental damages or offshoots such as the accentuation of global warming through the damage to ozone layer by chemicals such as methyl bromide.

In addition there is the problem of the deleterious effect on soil flora, affecting soil productivity and leading to other vicious effects including an increased need for chemical fertilizers. And one cannot afford to risk other dangers such as loss of honeybees affecting pollination and the effect on earthworms which are perhaps the farmers' best friends. The role of earthworms and the use to which this technology is being used will be discussed in some detail later. Last but not the least is the lurking danger of the development of resistance and resurgence in the pest population particularly in vectors of human-borne diseases. It is in this background that the concept of sustainable development has gained ground and acceptance as has been brought out so eloquently by Stephen Gleisman and colleagues at the University of California, Santa Cruz[4] in several publications.

A good example of the use of IPM to overcome consumer resistance is provided by the cranberry crop in Oregon, USA. Following the Alar poisoning episode involving apples, the consumers were turning away not only from apples but cranberries, where pesticides were being used in ample measure to control black-headed fire worms, vine weevils, girdles and some other pests. Biological control, pheromone traps as well as a cultural control strategy to drown black vine weevil larvae was used.

Parasitic nematode was also used. The use of a naturally occurring mineral compound, cryolite-sodium a fluoride of sodium and aluminium which acts as a stomach poison for some pests, was also adopted . All this has materially reduced the use of pesticides to save this crop which was introduced in 1985 and now covers 1500 acres. This crop accounts for 6 per cent of national production in USA which brings in about US $ 15 million a year to the farmers. Such a development has been made possible by R&D efforts of the committed staff of Oregon State University- which also shows a need for similar approach at home.[5]

Many of these overlapping concepts aimed at reduction or total elimination of pest use are covered by terms such as alternative, regenerative, organic, low input and sustainable farming. To these we may also add systems such as natural farming which is one end of the scale and permaculture, biodynamic, ecological possibly falling in between. This list of nomenclature is by no means exhaustive but these are the technologies or systems that are commonly in use or in the forefront. To many of the earlier descriptions and definitions of sustainable agriculture the Santa Cruz authors have argued in favour of the incorporation of social and economic dimensions and pointed out how these elements have been left out in some of the earlier descriptions instead of being brought to the fore.[4] This Group has come up with a definition which is broadly in tune with the one coined earlier[6] with possibly the addition of an element of non-exploitation and emphasis on this serving as a foundation for service to future generations. There is also a stress on this as a model aimed at a whole systems approach which would in turn foster an understanding of various ramifications and also take a holistic view of the various issues involved.

The whole systems approach advocated may cover three waves of social concerns—the natural resource availability, environmental change and human well being-ideas and waves which have essentially merged in the '40s and '50s, '60s and '70s and mid '80s. The last of these or the third wave has a strong element of not only national but global and inter country issues such as global warming, ozone depletion and not to forget acid rain amongst many other issues and phenomenon. These concerns have a global impact cutting across boundaries, highlighting the need for the adoption of a whole systems approach.

It is thus clear that the scope of sustainable agriculture as put forward is rather wide and varied involving not only principles of equity and social change but also institutional change according to the authors. Such a sustainable system should encourage productivity and optimum production both on a long term and short–term basis.

On these broad considerations, Denmark for instance initiated in 1985 a plan to reduce pesticide use by 50 per cent by 1997. Assessment of the Danish plans in 1994 shows that the targets were not being achieved fully, although these are expected to be fulfilled by 1997. However, an assessment by the World Wide Fund (WWF) shows that the targets to be achieved will involve increase in subsidies to organic farmers, possibly heavy taxation on pesticides and increase in fallow land where pesticides are generally not used. There are obviously many unanswered questions and road blocks in establishing a pesticide-load index or an environmental risk index in the light of a large number of variables. This makes it difficult also to set any scientific pesticide reduction targets. It has therefore been concluded that the reduction target of 50 per cent may not be within reach.[7] A recent review by Jorgensen[8] on the Danish plans to cut fungicide use, reports that while the 1994 targets of 20 percent reduction were in fact achieved, there are no clear signs as to what will be the actual position in 1997 with a target of 50 per cent reduction.

In Sweden also a programme aimed at pesticide reduction by 50 per cent has been under implementation. In Holland, a policy decision has been made to reduce pesticide use by the year 2000AD, going sector by sector. This awareness of pesticide danger is reflected for instance in Belgium where the pesticide use was 12 kg/ha as against Holland, where the use was 20kg/ha on an average during 1990. In Germany and UK for the same year on the other hand the use averaged 4kg/ha.[9] A recent report from Sweden by Emmerman indicates that the country's plan to reduce pesticide use has indeed gone beyond the expectations leading to 75 per cent reduction in use by 1996 and new policy initiatives are afoot beyond the current century.[10]

But it does seem that in the absence of a positive, serious, determined timely commitment and policy of the governments, there would be hardly any incentive to develop the alternative approaches to the present conventional agriculture. This apart, even after pesticide reduction policies and programmes backed up by field studies and full support of R&D

is organised, a close monitoring and enforcement alone could change the picture.

Yet another helpful sign is ever increasing consumer awareness which has led to an informed demand not only for organic farm produce, including beverages but even leather and textiles ware. The world over consumers are gladly paying anything like 25-100 per cent over and above the normal price tags for certified, assured goods. Surely this would more than compensate any reduced outputs during the initial 1-3 years period and also serve as an incentive and insurance against any possible crop failure, imaginary or otherwise.

This demand for organic is equally serving as an effective pesticide reduction reality in countries like the USA with a clear, tacit and open public and government support in this direction. On the other hand in countries such as India obsessed with any possible crop failure and disruption of food supplies or any drop in export earnings, there is reluctance on the part of the bureaucrats who are in total command, to take any chances. However, recently on account of threats from countries like Germany to cut off purchases of farm products, including animal feeds due to presence of pesticides even in very low, minute quantities, levels which seem almost difficult to achieve, the Ministry of Commerce is seriously concerned and there is hope that the policies and attitudes on pesticide use may undergo some welcome changes.

If this happens it would serve as a left-handed compliment to the handful of voluntary groups who have been so far, unsuccessfully, in the forefront of pleading for alternatives and have also been clamouring for the enunciation of a National Pesticide Policy—no doubt aimed at achieving reduction in pesticide use with the ultimate goal of a total eclipse of pesticide use in the country.

Thus one thing clearly emerges—even granted that pesticide use may not end in one go, the studies and experience gained world wide shows that in the majority of cases of un -informed farmers, the dosage actually used is invariably higher than what is recommended. Thus the first essential step towards pesticide reduction should be use of correct dosage. What IPM does, although it has several other important features and angles, it does invariably lead to substantial decrease in pesticide use and in some successful cases to almost zero levels.

All in all it is clear, as was the case in USA earlier and more recently in the Netherlands, that there is a need to plan out a joint programme based on controlled studies/trials by different groups and interests, drawing from various agricultural production sectors, such as cereals, fruits, and vegetables. This should be supported by a package of practices as also qualitative and quantitative targets and inputs. It would therefore seem that while NGOs and individual farmers could play an effective role, eventually it is the official agencies which will have to be drawn in as is happening say in USA and Europe with very impressive results. In fact there is reason to believe that even the involvement of the manufacturers interests in this exercise would be of mutual benefit , as their first hand knowledge in any such successful farm operations with reduced or zero pesticide input would convince them of the missed possibilities and opportunities and also induce them, hopefully, to promote and to look out for alternatives to pesticides.

The Organisation for Economic Co-operation (OECD) countries representing 24 industrial western countries where concern for pesticide damage has been quite pronounced has launched in January 1994 a 3-year activity on pesticides. The objective was to help the countries in assessing and hopefully reducing pesticide risks. This programme is to be directed by a Pesticide Forum composed mainly of Government controlled authorities as also representatives of the pesticide industry, the NGOs, farm and environmental groups as also some of the international organisations such as the European Commission, FAO, UNEP/ITRC and IPCS. In a way this is a follow-up of OECD's pioneering effort relating to formulation of the Codes of Conduct in respect of pesticides. The three main objectives set forth are promotion of sound, consistent, national registration procedures, re- registration of old pesticides and lastly to reduce risks to human health as also the environment from pesticides. Basically this would entail reduction of risk from individual pesticides, reduction of pesticide use and adoption of IPM methodically.[11]

One of the reasons that carried weight with decision-makers was the high costs involved in cleaning up water contaminated with pesticides. Take the case of the UK where it was estimated that if domestic water was to be made free from pesticides, the water bills would go up by 10 per cent in order to meet the EC standards. In fact the 16th Report of the

Royal Commission on Environmental Pollution on fresh water quality was seriously disturbed with the pesticide contamination of both surface and ground waters. The Report says that there was not only lack of data or any meaningful monitoring system, there was absence of any specific programme indicating which pesticides were to be tested for. Further the Report says the matter is further complicated due to the difficulties inherent in monitoring both ground and surface waters [12]

While placing the burden of the decision for pesticide use on the user, it goes on to support the basic precept of a reduction policy. It refers to the pesticide reduction time tables set forth in Germany, the Netherlands and Scandinavia and highlights the need for a similar action in the UK. However, for practical reasons, the Commission did not recommend any imposition of a time-frame.[13]

Yet a development that has found support as well as opposition is the decision of the EC which requires the same test data on adjuvants as on pesticides. While proponents of adjuvants consider the above decision unnecessary and unwarranted, the opposition points many instances where use of adjuvants has led to increase in pesticide dangers to health. A rather helpful sign in this direction is the pressure from consumer groups, the general public and NGOs on the metropolitan authorities for a cut on pesticide use in public places. In fact sometime in May 1993 a special conference was organised by the Pesticides Trust, London under the banner of Pest Control in Local Authorities, to discuss the present practices in vogue and the alternatives and future possibilities. Likewise the Royal Botanic Gradens, Kew, London had undertaken a mission in order to promote better environmental management and understanding of the plant kingdom. Several biological pest controls have been devised in the process apart from the control of cockroaches which is considered a serious pest problem in the UK.

On the other side of the Atlantic in California USA, pesticide reduction strategy had been proposed by Pesticide Action Network North America (PANNA) in 1992 which had 6 main components- establishment of specific goals:

- phasing out highly hazardous pesticides
- improved R&D for alternatives
- developing a programme of financial incentives for

farmers

- development of R&D programme and the provision of funding as incentives.

This policy had taken into consideration similar projects launched in Sweden, Denmark and the Netherlands and had projected a reduction of pesticide use by 50 per cent by the year 2000AD with 1992 as the base year. These plans covered more or less the same issues, plans and suggestions apart from financial incentives as had been adopted both in the USA and the European countries. In retrospect it would seem that the PANNA thinking was perhaps a bit ahead of the times.[14-19]

Another welcome development has been the announcement in June 1993 by the Clinton Administration in USA pledging to bring forward a relevant legislation during 1994 on the same subject of pesticide use limitation. While some aspects of this legislation were welcomed, there were areas of concern which led to serious criticism of the proposed measures. As a matter of fact the disappointment has escalated arising from the subsequent decisions of the USA administration to nullify the Delaney Clause which has helped restrict the entry of many highly toxic chemicals in farm use–pesticides which have been implicated in the causation of cancer.[20,21] So great is the dissatisfacti on amongst public interest groups that a number of important and active NGOs in the USA have joined together in a Coalition, named Beyond Pesticides, to jointly campaign against the going back by the Clinton Administration on its own earlier commitments and decisions.

The US reduction signals were wide-ranging and positive as these involved a complete review of a large number of issues involved. These covered food safety and the consideration of a new Code for risk tolerance as also new tolerance settings with cancer in mind. This also involved a review with children in the background as also worker exposure. The policy parameters had also covered setting goals for IPM, review of each pesticide individually, reduced risk policies, expansion of R&D and extension facilities. Apart from the goal of IPM in 75 per cent of the US farms by the year 2000 AD, there were detailed plans for studies on worker exposure. Further, instead of pesticide by pesticide approach a new cluster approach was on the anvil by the USDA. Biological pesticides/biocontrol agents were also being given high priority for registration

purposes and these in fact constituted 50-70 per cent of the all the new ingredients that came up for registration.

However, as indicated earlier it seems that considerable confusion has arisen on account of the sudden *volte face* by the US Administration which has sent out alarm signals, disquiet and concern amongst many groups not only in the USA but elsewhere as quite frequently the policies and programmes in USA find their way to attract public and Government attention around the world, which in turn makes the task of local groups and Governments that much easier.

The Gottingen Workshop on Pesticide Reduction

A workshop was sponsored specifically by the FAO in 1994, following the 1992 meeting of the FAO-UNEP Panel of Experts on IPM. [19] This was the result of the concern at the over- or mis-use of pesticides as it was the general feeling that many of the donor countries were putting pre-conditions and pre-determining the need or the essentiality of pesticide use in their aided projects. Of special concern was the finding that the various types and forms of hidden and indirect subsidies often impede the diffusion of IPM technology which necessitated an incisive look at the pesticide policies in vogue. Accordingly in 1992 three desk studies were commissioned, two by the FAO and the third one by the World Bank in order to review donor policies, role of NGOs and review of national policies respectively. Based on these reports apart from presentations by some 17 participants at the Gottingen Workshop, gist of Proceedings have now been broughtout from which the following material has been assembled in the area of pesticide reduction in practice and future projections. The first paper was that of Hermann Waibel which discusses the economic framework of pesticide policy studies and the second one by Gerd Fleischer both from the Institute of Agricultural Economics, University of Gottingen, the host institution of the Workshop. These effectively bring out, how the entry of donors in the area of agriculture and use of pesticides was to ensure food security and for this purpose a technological package which included inputs like HYV seeds, fertilisers and pesticides were being worked out. How these external inputs were being offered to farmers at low costs to familiarise them with the new technologies leading to excessive use has been brought out by one of the study. Fleischer has also compiled a list of the donor organisations

world-wide who have put up selected guidelines on pesticide policies.

The UN was perhaps the first body in 1982 to have prepared such Guidelines while the World Bank had these in use in 1985. Credit facilities and various forms of direct and indirect subsidies were a part of this strategy. In other words the use of pesticides was being promoted and supported both by way of technical aid and financial grants from international and bilateral donor agencies. This aid to national governments was justified on account of acute food shortages in several countries quite often on account of the population explosion, significant crop losses and for improved productivity.

The crop losses were sought to be controlled through improved pest management by use of powerful pesticides. Well, as has often been said about aid, there is no such thing as aid without strings or returns to the donors. This takes many diverse forms and shapes and quite often serves as a sound investment for the future by way of trade and supply of goods- in this case the three inputs referred to above, apart from many other political returns . Take the case of Philippines where the FAO has been working for promotion of the IPM program. The more toxic pesticides are also the least costly, the banning of which would force farmers to either shift to other higher priced chemicals, not use chemicals or switch over to biocontrol agents and other forms of control including the age old indigenous methods.

Pesticides are also part of a commodity grant from Japan to Philippines since l977. To cap all this, according to Agnes C.Rola of the University of Philippines, Laguna, despite adoption of the IPM by the Government in 1986 under inspiration from the FAO, pesticide imports in 1991 increased by 68 per cent for technical materials and 45 per cent for finished products compared to 1986 levels. The Asian Development Bank for instance has recently funded field implementation of the biological control of diamondback moth (DBM) in cabbage in the highlands after it was found that the farmers were using cyanide to control the moth.

In the case of Indonesia, IPM, once again with the help of FAO, had made several important gains after the crisis the country faced in 1986. By l989 the countrv eliminated subsidies saving the country an estimated US$l00 millions per year apart

from other gains. According to Jonathan Pincus of the FAO-IPM project in Indonesia, despite these important gains numerous highly hazardous pesticides continue to be imported, produced and marketed in Indonesia as the existing enforcement of bans is lax indicating a dichotomy of the situation. The author feels that the continued success of the efforts on IPM will depend not only on political will but also on action at the grassroots level—the farmers, the NGOs and the local authorities in the Government.

A paper by Akinwumi A. Adesina, a senior economist at the West Africa Rice Development Association (Warda) based in Cote d'Ivoire , suggests that pesticide use in West Africa differs country-wise, being the highest in the coastal countries. Most pesticide use is for cash crops, notably cocoa, coffee, cotton and therefore the major share of pesticides use is in Cameroon, Cote d'Ivoire, Nigeria and Ghana. There have been noticeable ups and downs possibly on account of the local economic situation and the withdrawal of subsidies. This situation has been further aggravated due to the absence of effective plant protection regulatory organisations in most of these countries.

Another contributing factor appears to be that a large number of these countries have been receiving large sums of free foreign aid in the form of pesticides. Such bilateral help has been either for direct help for food production programmes or for any sudden outbreaks of pests, including locusts, grasshoppers or granivorous birds which are a serious problem in some of these countries. The pesticides are either sold at very low prices to farmers or given to the plant protection authorities for use in serious outbreaks of pest. For instance Gambia, Guinea, Guinea-Bissau, Senegal, Cameroon and Mali had received substantial quantities as aid from Japan under their KR-2 programme. Benin on the other hand had received large quantities from the GTZ programme. This has obviously fueled increased use in the recipient countries apart from making them indifferent towards using non-pesticidal technologies and approaches including IPM. A majority of these countries were also providing heavy subsidies to farmers for pesticides. During the 1970s and 1980s, Nigeria provided high subsidies while Ghana, Cameroon and Cote d'Ivoire have been traditionally subsidising pesticide use for cocoa and coffee although these subsidies are now on the wane. Cameroon was subsidising 100 per cent for its major cash crops for exports, which included coffee, cocoa, bananas, cotton and oil palm. Likewise cote d'Ivoire gave 100 per

cent subsidy during 1990-91 for the cotton crop. Togo was following the same policies for cotton until 1989 after the crash of cotton prices and these have since been withdrawn totally. In Gambia the Government had subsidies for pesticides used for groundnut and cotton production whereas Mali exempted these from the local sales taxes. In Benin as indicated the pesticides were heavily subsidised until 1988 due to German grants. There have been other methods used for promoting sales of pesticides at subsidised rates through the exemption of customs duties and/or sales tax or even preferential exchange rates as for instance in Ghana. In some of these countries there are indirect benefits through provision of subsidised credit facilities to farmers directly or to the importers. In some cases pesticide use is made mandatory for farmers for certain crops in order to meet export requirements.

Atleast in three countries—Mali, Cote d'Ivoire and Burkina Faso–farmers must spray their cotton crops in order to qualify for credit services and other complementary inputs like fertilizers and herbicides. These agencies also provide farmers pesticides on credit to be returned after the harvest. The Proceedings also provide some brief details of credit and cash purchases of pesticides in Cote d'Ivoire as also pesticides received as aid by Cameroon from Japan in 1992 and supply of equipment and protective gear to farmers in Gambia during 1992-93. It would seem therefore that in general the farmers are left with no alternative other than the continued use of pesticides which paradoxically are now an unwelcome guest as an additive or a residue in farm products in the importing donor countries themselves.

According to Octavio A Ramirez, of RENARM/CATIE Project, based in Turrialba, Costa Rica, the policies in Central American States is biased in favour of pesticides as the expenditure for these is entitled for agricultural credit. The writer also raises an important issue of the public costs of workers affected adversely by pesticides, damage through pesticide food residues and the damage to ecology and environment through pesticide use. It has been brought out that during the former decade Nicaragua heavily subsidised pesticides which was also the case with Honduras and to a lesser extent Costa Rica, where some of the specific pesticides have been sporadically and under emergency situations been subsidised. There are also subtle subsidies in some of the countries through preferential credit in the case of pesticides.

Likewise in Brazil until 1982 subsidised credit led to mis-use and over-use of pesticides specially in the case of cotton However, since the subsidy has tapered off the farmers have been trying other innovative, alternative methods of pest control with success. The picture of IPM in Brazil has been presented in a paper by Campanabolas et al.

The Gottingen Conference may thus well serve as a landmark towards a new impetus to pesticide reduction so painstakingly and convincingly brought out in Part B of the Report which deals with the conceptual framework for the Pesticide Policy Studies based on the results of the discussions at the Conference. The analysis of the present situation, existing crop protection and pesticide policies which also covers analysis of prices and subsidies or taxes, direct and indirect has been fully covered. These include subsidies to distributors on sales, use of low priced chemicals through donor or Government contributions, supply of foreign exchange at favourable exchange rates, low tariff rates, reduced sales tax, subsidies via special low prices on energy sources, equipment etc.

In addition to this there are interventions of different kinds in input and commodity markets such as obligation to use pesticides in order to be eligible for insurance or credits, limitation of credits in respect of non-chemical pest control. The Report also covers in quite some detail the impact of regulatory policies, the effect of R&D and the extension system, the farm characteristics, including farm profiles.[19]

The conceptual framework outlined in this analytical report if followed, would be of considerable help in thrashing out a pragmatic National Pesticide Policy in any country provided there is a political will which alone can keep the many differing opinions and vested interests especially of the strong band of manufacturers both indigenous and from overseas, the distribution and the formulator interests in check. Perhaps under such a broad cover the manufacturers may be weaned away to switch over from chemical based products to the other alternatives—be these biological control agents, plant based products or even the re-discovery of indigenous methods and products which through sheer neglect have remained in disuse. Hopefully care will be taken to ensure that these do not fall under the new mysterious net of intellectual property rights.

A sense of national obligations and call to duty in aid of the Earth and its threatened environment including the ozone layer may possibly serve to attract the attention of not only those directly involved, to desist from making profits through poisons. This should also be a signal to the international UN bodies and the national Governments to take early and effective steps to protect the health and welfare of its citizens specially in the light of widespread illiteracy and consequent lack of interest in the matter.

In so far as India is concerned a clear lead was given by a group appointed by the Department of Science and Technology (DST) which in 1987 brought out a landmark Status Report vis-à-vis consumer protection. This report amongst other things aimed at pesticide elimination, also drew pointed attention to the Ottawa Declaration adopted on June 5, 1986 on the World Environment Day. Later in 1988 a National Core Group Meeting was organised once again with the support of the DST to highlight problems and alternatives. This was followed by setting up of a National Pesticide Action Committee which called upon the Government. to adopt a National Pesticide Policy. A notable offshoot was the production of a video, The Killing Fields in 1992 again with support from the DST which highlighted the alternatives. Incidentally this powerful video has not been screened so far on the Indian Government controlled TV channels, without any doubt, on account of the powerful vested interests.[23]

This campaign was followed by several seminars and advocacy in the country in support of the several important recommendations made which included the issue of pesticides to farmers against a prescription from a qualified technocrat. While these efforts have helped generate considerable attention, the fact remains that there has been no clear forthright enunciation of the Government policy on reduction of pesticide use much less any clear programmes or strategies in this direction. [24]

However, considerable work has been done by the Indian Council of Agricultural Research (ICAR) through its 16 R&D units spread over the country in developing biological control agents. Likewise the Department of Biotechnology (DBT) have in hand some 35 projects for biological control of plant pests , diseases and weeds which according to their report (1994-95) covers pilot projects on cotton, tobacco. groundnut,

pulses etc. on some 11,700 ha. land in the country. A look at the program shows that this is laudable but only a drop in the ocean as the many important crops like rice and wheat etc., are not covered. The ICAR has not given any indication of the land area covered by their trials although there also the crops covered are by and large the same as those covered by the DBT showing a clear case of overlap of the limited R&D facilities.

The main responsibility for implementing or transfer of technology rests with the Government of India and the State Governments. Despite all the statements, claiming existence of over 125 Biological Control Laboratories for the control and surveillance over 4.64 lakh(lakh= 0.1 million) ha in 1993-94, a target of only 1.42 lakh ha. was made to cover mostly fruits and vegetables crops apart from cotton, castor and sugarcane. It may be remembered that the total cropped area in India is some 180 million ha. including area sown/irrigated more than once. In contrast in 1980 as per USDA some 20,000-30,000 farmers or 1 per cent of USA's total were already practicing sustainable agriculture, which has swelled by leaps and bound the world over. From the reports and other activities it seems clear that the Ministry of Agriculture is more concerned about detecting adulteration of pesticides for which a number of high powered laboratories have been set up in order to 'protect' the farmers. It would seem that the pesticide-lobby is too strong which also explains the non-emergence of any National Pesticide Policy, although on 15 March 1995 during the Budget presentation in the Indian Parliament the Finance Minister did refer to the need for adoption of IPM. It is also partly this lacunae and weaknesses both in the government and ICAR set-up that has led to the DBT entering this field, normally the domain of the Agriculture infrastructure.

Recent pressures from the farm products importing countries such as Germany who are insisting on organic foods, including cotton, leather and even jute, apart from animal feeds and animal foods, is now worrying the powerful Ministry of Commerce responsible for export earnings. This is held vital by the government in the new globalisation plans and the GATT era, leading to some intervention, beyond the present cosmetic approach to the problem. Obviously it has not dawned on our R&D setup that it is not enough to merely seek biological control agents, important as these are, but the matter has to be viewed in a far more depth and a whole

systems approach would be needed which would mean using a complete set of integrated technologies and knowledge whether these be pest resistant seeds, use of cover crops or use of manures, crop rotations, systems and technologies which have already been demonstrated not only overseas but within the country itself. Possibly the pressure from the commerce angle will be too strong to ignore and will awaken the powers that be towards an early development and adoption of a pesticide reduction policy with pragmatic programmes and strategies. [24]

A number of important papers and publications based on independent studies have come out in support of the pesticide reduction following specially the disturbing reports on their involvement in hormone havoc dealt with in earlier chapters. Cutting pesticide use, keeping agriculture strong with lessons from northern Europe is the theme of a recent paper. The paper gives details of National Pesticide Reduction plans and target of 50 per cent reduction set down by Sweden, Denmark and the Netherlands with different deadlines.[25] The Great lakes in Canada/USA serve as a fine example of what needs to be done specially as these are considered vital to agriculture of both Canada and USA form the subject of a detailed and well documented paper by Polly Hoppin and co-workers. Incidentally the Great lakes constitute 20 per cent of the worlds supply of fresh water.[26] A recent Report from the California Policy Seminar (CPS) Group headed by William S. Pease throws light on strategies needed for reducing environmental health impacts of pesticide use with special reference to California. The report touches on increasing pesticide use in California with naturally improved turnover in trade.[27] Details have also been furnished of the ten top high hazard pesticides used in the State indicating the major crop uses for each. The first on the hazard list is Methomyl and the 10th, Simazine.[28]

The CPS group in another well argued report proposes imposition of taxes on pesticide use which may in turn be used to constitute a Fund for Environmental Protection as also for IPM. Three alternative tax designs have been proposed for evaluation and implementation depending on the local situations. Behind the proposal lies the now well-known dictum of 'polluter pays'.[29]

* * *

Chapter - 11
Organic Farming

We have touched earlier on certain aspects of Sustainable Agriculture (SA) or Alternative Agriculture (AA) during the initial stages of the developments in this sphere, specially in USA. Reference has also been made to a few successful examples of case studies in USA, where the AA movement first took concrete shape, fully supported by the US Government agencies from 1980 onwards.

Reference has also been made to a few successful examples in Oregon and Kansas States in this area. Likewise reference has been made with supporting experimental data on ecological farming as compiled by the ETC-sponsored Dutch group in the South India spread over 3 years.[1]

This has been followed up with a close look at IPM, the new, hybrid technology developed in the West, obviously aimed at minimal use of pesticides alongwith other knowledge and experience, all aimed at getting the maximum from the soil. This takes into account that the soil is not inert but a living entity with all the biological organisms it harbours and sustains for mutual benefit and survival.

This concept of the need for maintaining the supremacy and health of soil that receives and gives is the base of the entire concept of sustainability of agriculture. Whether it is nitrogen fixation, use of minerals, cropping pattern or the use of cover crops or organic composts/manures or use of earthworms is all a part of a great re-cycling exercise including the use of plant pesticides.

In fact it appears clear now that the most crucial element which would determine the success of farming without off- farm inputs is the nutrient content of the soil. It appears to be this nutrient strength which traditional farming can easily

provide, if we understand the living nature of the soil, that seems to be the foundation for the resistance of plants to pest attack. The fact remains that with the entry of pesticides, high yielding variety (HYV) seeds and chemical fertilizers, even though these have undoubtedly led to increased yields, in some cases quite dramatically, the serious interference specially of chemical inputs has interfered with biodiversity, soil life and soil health causing salinity, water-logging and soil erosion, leading to drought. These factors, apart from any other situations, particularly mono-cropping patterns have all combined to render the land fragile. Some of these factors have been clearly brought out in Agriculture and People Report by Dudani and Jill. The Report also highlights both the direct and indirect costs of fertilizers and pinpoints a wide range of possible health hazards of pesticides and their adverse effect on the land base. Some of these issues and concerns have already been touched upon in the preceding Chapters. [2]

The thrust of the promoters of alternative Agriculture (AA) or Sustainable agriculture (SA) and various other systems, variants of the same philosophy, therefore includes crop rotation schemes in order to interrupt weed and insect life cycles. In addition, ridge tillage, mechanical cultivation or the use of allelopathic plants which emit natural herbicides, adjustments in rates and time of planting, row and seed spacing as also altering the choice of crop or variety are all a part of this arsenal. Likewise the use of plant pesticides or biological control agents are a part of this mechanism. As in the case of the newly emerging IPM, the traditional farmer relied on regular scouting and observation apart from the use of traditionally developed pest resistant variant crops, multicropping and use of indigenous technology for pest management.

The experienced farmer also had gained knowledge on the potential of parasites and predators and managed to harness these in his favour even though much of this knowledge was gathered on the basis of thumb rules and not always fully or much less scientifically established as is the situation today. This situation of sustained and authentic technology based on R&D passed on to the field through trained extension linkages in well off countries has ensured successful implementation and transfer of technology in respect of AA/SA. This switch over has been further hastened and made both effective and viable by the enlightened consumer as we shall see from the growth of organic farming but more importantly the evolution of

Organic Standards and the strong marketing mechanisms which have brought in strong and newer dimension in helping the upsurge in the revival of the AA movement.

Natural Farming

Before we proceed to discuss various SA systems be these called organic, alternative, low inputs, biodynamic, biological, ecological, regenerative, permaculture and/or by any other synonymous name and system we shall briefly refer to a novel method of natural farming developed by Masanobu Fukuoka which is aimed primarily to reverse the degenerative system of present day farming.[3]

Natural farming as developed and practiced by Fukuoka requires no machines and, of course, no chemicals and very little or no weeding. This method requires no plowing or prepared compost. Under this farming system no water is held in the rice fields throughout the growing season as has become the practice for centuries in Asia as also in other countries. The farms have remained unploughed since the start some 40 years earlier when he ventured in this vocation. And yet the yields compare favourably with other farms. The system requires less labour, creates no pollution and importantly does not require the use of fossil fuels. In fact Fukuoka fondly calls this as "do nothing" farming which, of course, is a euphemistic over -statement. As a matter of fact, believe it or not, his crops of rice and other grains are grown each year simply by scattering seed onto the surface of an unploughed field.

Wendell Berry, who had studied and worked at the Fukuoka farm in the Shikoku area overlooking Matsuyoma Bay, consisting of 1.25 acre of rice fields and 12.5 acres of mandarin orange orchards, says the main method aims at working with nature rather than trying to conquer it. The farm is on the island of Shikoku in Southern Japan.

Fukuoka while believing in the many virtues of traditional farming as practiced in his country feels that it involves redundant work. In the fall, Fukuoka sows seeds of rice, white clover and winter grain on to the same fields and covers them with a thick layer of rice-straw. The barley or rye and the clover sprout up right away, whereas the rice seeds lie dormant until spring arrives.

Thus while the winter grain is growing and ripening in the lower fields, the hillsides orchards are in full bloom and citrus yields start from mid–November to April. Rye and barley are ready

in May. The straw, after grain is threshed and winnowed, is scattered unshredded across the field as mulch.

Water is then held in the field for a short time during the monsoon rains in June. The idea is to weaken the clover and weeds and give the rice an opportunity to come up through the ground cover. The field is then drained, allowing clover to recover and spread beneath the growing rice plants. From then on, until harvest, the main task is to maintain drainage channels and mowing the narrow paths (walkways) between the fields.

This system is in sharp contrast to the traditional farming which for the same period requires hard labour inputs. Rice is harvested in October and the grain hung to dry for threshing. This is then time for autumn seeding-synchronising with early mandarin orange varieties becoming ready for harvest. The yields of Fukuoka farms are estimated between 1,100 to 1,300 lbs of rice per quarter acre, which is comparable to either the traditional or chemical farming in that area of Japan. In fact the yield of his winter grain crop is often higher as compared to chemical/traditional farms both of which use the ridge and furrow method of farming.

What then is the difference between natural, traditional and chemical methods, one may ask. Perhaps the answer lies in improvements in soil—in terms of fertility, structure and increased ability to retain moisture in the Fukuoka method. This is similar to the traditional method where the farmer gets yields in direct proportion to the quantum of compost and manure he uses.

Incidentally the traditional farmers have been known to raise 2 crops in a year in Japan in the same field for centuries without reducing the soil fertility. The farmers had maintained organic matter in the soil by rotating crops, by use of compost and manure and by the use of cover crops. The stoppage of these and switch over to chemical fertilizers depleted humus in one season, caused deterioration in soil structure, weakened crops and became dependent on ready-made chemical inputs. However, as per observations the soil under chemical farming becomes life-less and deprived of its fertility in a short period. For instance observations have been made at the Gloria Farm, Pondicherry, which more or less has used a similar system or what may be termed as organic or ecological methods over the last 10-15 years.[2]

Yet another innovation of this natural farming is that rice can be grown without flooding the field through the growing season, as is normally the case. In fact according to the experience gained by Fukuoka, there is reason to believe that his method gives better yields of rice due possibly to deeper roots and resulting strong stems. The old glutinous rice grown by him is estimated to have between 250-300 grains per head. Obviously use of mulch increases the ability of the soil to retain water which in many cases completely obviates the need for irrigation, opening up new vistas for rice and other high-yielding crops. This method also not only overcomes the usual problem of soil erosion but leads to effective rehabilitation of damages arising from careless agricultural practices.

While plant diseases and insects are present in the fields as also in the orchards, the experience is that crops are never devastated although some of the weaker plants may be damaged. This confirms the general belief that the key to the pest disease and pest control lies in growing crops in a healthy and nutrient environment. In the case of fruit trees of the Fukuoka Orchard, these are not pruned and allowed to take their own natural shapes and form. Likewise vegetables and herbs are grown on the orchard slopes with a minimal of soil preparation.

In Spring, seeds of burdock, cabbage, radish, soyabeans, mustard, turnips, carrots and some other vegetables of local interest are mixed and broadcast on the field just before the onset of spring rains. This system works well in view of the humid climate and continuous rain and may not suit every situation elsewhere, like all holistic farming methods. It is advisable and necessary to cut back the weeds when vegetable seedlings are young but afterwards there is no problem. Quite often some of the vegetables keep growing year after year without planting, from the fallen seeds. More importantly Fukuoka method relies on spiritual health of the individual—a situation similar to the biodynamic farming and even for organic farming .

Ms. Enid Wonnacott who has been certifying farmers in Vermont, USA, since 1987 believes that one cannot farm organically without what she calls a "connection" to a spirit of life. She holds that a philosophical support system is needed to nurture one's organic farming practices. She is convinced that transition to organic system just for financial benefits may not be either easy or successful. It is not uncommon to see this kind of holistic thinking, serving as a guiding spirit for farm families

who have switched over or are switching over to the farming sans chemicals.[4]

Fukuoka believes in a balanced eco-system, with insect and plant species maintaining a stable relationship. On his farm, dragon flies and moths fly up in a flurry as also the honeybees. The plants harbour insects, spiders, frogs, lizards and other small animals as also moles and earthworms beneath the surface. His system is based on four basic principles:

* No plowing
* No chemical fertilizer or prepared compost
* No weeding or tillage
* No chemicals

The above briefly outlines the philosophy and practice of natural farming by Fukuoka which has brought him widespread recognition around the world. Fukuoka has used the concept of one straw to illustrate its importance after the experience of the use of straw on rice fields and rice crop growing and piercing through a tangle of weeds and straw on land surface.

Fukuokas' natural farming and one-straw Revolution have set new trends in the footsteps of Sir Albert Howard, a British officer, stationed in India in the early 1900s. Through his trials and observations at Indore he had established that healthy soils created healthy plants and animals. He also concluded that humans created the conditions for greater resistance to pests and diseases. His system, for composting is referred to as Indore method and is in use even today. Sir Albert wrote two books—*Agricultural Testament* (1940) and the *Soil and Health*.[4]

This pioneering work led to the creation of the now powerful Soil Association in UK by Lady Eve Balfour in order to create awareness of soil management amongst gardeners and farmers. The Soil Association located at Briston, Avon, UK, under its Chairperson Charlotte Mitchell has now emerged as a powerful instrument for promoting production and marketing of Organic foods and for protection of the rights of producers as well as quality for consumers in UK. Other pioneers in this field have been J.I. Rodale, Dr.William Abrecht, Louis Bromfield in USA. Reference has been made earlier to other leaders in this area.

Indigenous traditional system of farming

In traditional systems, including organic farming the harmful effects of pests including weeds, large insects, rodents, birds

has to be minimised. This has been achieved over the centuries through shifting cultivation (called Jhum in north east India) intercropping, crop rotation, sanitary measures such as removal of infected plants and of course use of pest-resistant varieties.

Use of trap plants is often made to control pests in indigenous farming. For instance to control cottonboll weevil (*Anthonomus grandis*) , cotton is sown early and/or allowed to stand after harvest to attract these weevils and these are then destroyed. Crop rotation, selective use of crop species and varieties achieve the same purpose—to keep pests at bay.

It is also for these reasons that mono-cropping does not fit in the organic farming system. Same is true for use of a wide range of plant varieties, to provide a biodiversity in order to prevent/ reduce pest damage. In any case this serves as a form of crop insurance apart from providing varieties to suit a wide variety of soils, water availability which differ widely sometimes in the same place.

Multiple cropping which in effect means growing two or more crops in the same area, simultaneously or following each other is yet another system used with advantage. Agro-forestry, agro-silviculture or what is termed as multi-storey cropping is all a part of this drill to prevent pest damage and improve production and for improving soil fertility. We have so far touched largely on various experiences and possibilities of organic method in the field of plants.

However, the organic farming or the traditional indigenous systems were not evolved in such isolation since livestock has always formed an integral, if not, an essential interdependent component of the traditional farming. In situations such as we find in the developing countries there is not only mixing of livestock as mixed holdings but total integration of crops and livestock This seems to offer the best hope for returning to the traditional family or community farming. Such a system is in fact being followed not only in the Third World countries which suffer from a resource crunch, but also by many successful organic farms in the USA and Europe. A brief reference will be made to this area but for detailed information, references will be cited.

It is this integrated farming approach which has sustained many civilisations through difficult periods and provided food and subsistence security. This apart, there is an

effective transfer of nutrients and more importantly, energy from animal power, through use of draught animals by providing not only for traction and transport of inputs and outputs but even for lifting of water from underground wells.

In many situations aquaculture can easily be integrated in this system as is the case in vogue with rice cultivation in Asia. Many of the surplus farm residues from manure, weeds, tree leaves etc., and also crop by-products such as maize, rice bran serve well as food for fish and these are converted into high grade fish protein foods.

This model of integrated rural farm families has been successfully extended to city farming need for which has arisen in view of the high human concentration in metros around the world. This will be briefly discussed later.

While poultry, ruminants, pigs and use of camels in pastoral areas provides products such as meat, milk, eggs, wool and hides there is also a potential for involvement of large unconventional livestock such as camel, llama, alpaca, Yak, banteng, water buffalo, eland, oryx and deer. Small animals such as capybaras, cane cutters, snails, frogs and reptiles also fit in this ecological system. [5-7]

Use of cover crops, green manures and rotations

It may be said, again, that cover crops, green manures and rotation of crops help in the prevention of erosions, help maintain or even build fertility and organic matter as also soil life. These also help to disrupt and damage habitats and sometimes life cycles of pests and pathogens. This apart, there is reduction and suppression if not the total elimination of weeds. All these gains go to improve and enrich crop biodiversity leading to improved biological as well as economic factors. Green manure and cover crops are specially of value in moist climates.[8] They provide biomass from leaves, stimulate soil life and protect the soil surface. Leguminous cover crops as also leguminous green manure, rich in soil microbes also fix atmospheric nitrogen and enhance plant growth. Used as a fodder for animals, it helps the production of animal manure for crops. Some of these also serve as green or living mulch thereby reducing water evaporation from soils particularly in semi-arid locations. Some of these have even been shown to possess pesticidal properties and have value for plant protection e.g., *Crotalaria ochroleuca* and *Tephrosia candida*. There is, however, a feeling that some of these may possibly compete with the main

crops but the overall balance seems to be in favour of using cover plants specially for vulnerable soils and farmers with limited resources.

Chuck Ingels describes experience with a wide range of cover crop species over some 1,300 acres in California since 1974.[9] One successful mix is that of perennial grasses, meadow barley, covar sheep fescue and annual forb crimson clover. From this experience a mix of Blando brome and annual clovers has emerged. On sites which are less fertile, in order to control erosion, use is made of a green manure blend of common purple and Lana woolly pod vetches, Austrian winter pea, bell bean and either oat or barley. The crops vary with soil and other needs. Several growers have used California's native perennial grains with varying success.

In another report by Rachid Hanna and co-workers the value of cover crops in vineyard pest management and nutrition management has been highlighted. This shows the effect of cover crops on agro-ecosystems developed. In general the study shows a reduction in leaf-hoppers using winter legume/grass cover crops. Cover-crops in general gave positive benefits on vine nutrient status after the 2nd/3rd year. The weed control by the cover crops varied although perennial weeds obviously were not controlled .The studies are continuing to gain higher insight into the utility of cover crops in Grape-vine management.[10]

Another survey on cover crops analysed the major barriers to the adoption of this technology despite the obvious benefits which have been observed. It seems there is need to develop possibly new varieties of cover crops to fit in certain situations such as crop rotation, soil and weather conditions and of course cost-benefit analyses and related operational information, including optimum planting times.[11] On the same lines, a no-tillage tomato production system using hairy vetch and subterranean clover mulches has been developed successfully at the Maryland Research Centre, Beltsville. However, weeds were controlled through the use of herbicides as needed. Likewise NPK solutions were given weekly through driplines. Although this cannot be accepted as an organic system there seems a great potential in the method through use of technologies which could well eliminate use of chemical inputs.[12] David Chaney in a recent paper brings out the strong role of the cover crops in the central coast farming systems of

California specially for organically grown bell peppers.[13] Robert L. Bugg in two recent communications discusses the management of cover crops in orchards or vineyards. One of the first looks at seeds,seedlings and the fate of cover crop derived nitrogen apart from the root -zone biology and the nutrient uptake. In the second part, Bugg covers the plant community dynamics and allelopathy with special reference to the farming systems in California.[14,15]

Trees, shrubs, cover crops, grain legumes, grasses, weeds, ferns and also algae provide green and inexpensive source of organic fertilizers. These can contribute 30-60 Kg of nitrogen per ha annually. In fact deep rooted green manure crops used in rotation help recover nutrients from the subsoil which had leached away. Several leguminous cover crops are also able to establish deep root systems in acid soils. Some 49 fallow plants have been identified and tabulated starting from *Calliandra sp. to Vignae sp.*[16] Alley cropping and integration of trees is commonly seen in traditional farming systems in West Africa and Costa Rica using tree legumes e.g., *Erythrina sp.* These are also used for providing organic material for mulch. Other systems that are followed usefully and successfully are sowing bush legumes amongst food crops, live mulching, shaded green manures specially in fruit orchards, coffee plantations, multi-storied kitchen gardens and similar situations. Both N-fixing leguminous and non-leguminous plants are generally used which includes trees, creepers and bushes. Two leguminous plants, velvet bean and sunhemp have found wide application specially since sunhemp helps control insects. This quite often calls for the use of suitable *Rhizobium* strains.

In the North-east of USA, farmers have been using cover crops and green manures which include alfalfa, clover, oats, and Ryegrass, Sudan grass, Hairy vetch, soybeans, millets and even some weeds.[17] The use of such plants of course will be determined by the type of soil and the season of use. Use of cover crops is a science which needs to be understood carefully to ensure that these do not turn into weeds or that such crops do not become a source for harbouring pests and diseases. On the other hand cover crops can also be used to attract beneficial insects such as lady beetles. At the Centro Internacional sobre Cultivos de Cobertura (CIDICCO) in Tegucigalpa, Honduras, Central America, considerable work has been done for cover crops- especially use of legume

species in tropical climates at higher altitudes.[18]

Use of Runner Bean (*Phaseolus coccineus*), a legume associated with corn has emerged as an excellent option. Apart from providing nitrogen through fixation and otherwise, it is also resistant to pests like leafhoppers, flea beetles and cutworms. Some other promising species found in Mexico are Sweet Clover (*Melilotus sp.)* which also grows well in association with wheat and oats.

Ebo (*Vicia villosa)* is common legume also useful in intercropping with oats and wheat. Another useful variety is Horsebean (*Vicia faba*). Chick pea, a legume is also common as a green manure/cover crop. Choreque (*Lathyrus nigrivalis*) is yet another annual legume as inter-crop with corn in Guatemala . Use of legume cover crops in orchards of tropical fruit plantations, legume covers, for oil palm plantations, such as Pueraria, Desmodium have been in vogue in Asian countries like Malaysia. But legumes are now being commonly used in Costa Rica for soursop, citrus in Honduras and Surinam and for bananas in Panama. Use of legume cover crops has now also spread to oil palms in the Honduras, all aimed at weed control, nitrogen fixation and improvement in soil, biodiversity including earthworms.

Tropical Kudzu (Pueraria phaseoloides) is another popular legume cover crop specially for control of weeds. Leguminous cover crops also are used as a powerful vehicle for use with nitrogen fixing bacteria. These work very well and profitably as in case of beans and maize.[19]

A number of symbiotic (*Rhizobium* sp.) strains have been developed by the Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia, especially for mountain regions. Scientists at the CIAT have also reported that deep-rooted green grasses can remove as much as 2 billion tons of carbon dioxide —a green house gas, from the atmosphere annually. Perennial grasses, *Andropogon gayanus* and *Brachiaria humidicola* are estimated to convert some 53 tons of carbon dioxide per ha. yearly into organic matter or as much gas as a car emits in 133,000 miles or 213,000 Km. Andean South American large beans and smaller beans of Central America have been evolved over 10,000 years earlier in that region. Beans vary not only in size but in their ability to resist diseases, pests and other stresses. CIAT is working to move genes to confuse bean pathogens. The CIAT beans that resist *Fusarium* wilt are now being used to develop resistance to varieties in Colorado,

USA.[20]

Genes in wild Mexican beans can help control the Mexican bean weevil, a pest that destroys some 25 per cent beans during storage in Africa and about 15 per cent during storage in Latin America. Thus the use of biotechnology with indigenous wild varieties not only of beans but other crops can save losses which are generally not easy to prevent in HYV seeds, according to these reports. It is thus clear from a few examples of cover crops and green manure that there is a vast area of possibilities world wide waiting to be exploited, provided our scientists keep an open mind, share knowledge and resources and work and act globally.[20]

Use of Compost and Manure

By all accounts, the use of compost and manure in organic farming is essential for successful operations and is a key to keeping in abeyance not only chemical fertilizer but also pesticides. Compost is made up of broken down plant and animal matter and serves as a well balanced slow-release supply of plant nutrients. It serves as humus and also supports the growth of parasites and predators. In addition to various methods of compost-making, specially composts such as those used by bio-dynamic farmers are also prepared which follow a certain set procedure including temperature control mechanism.[21]

Organic manures are prepared from raw material with some care as these have to meet certain organic certification standards and have to be stored for atleast 60 days—a precaution, as is done in case of cheese made from raw milk in order to destroy any possible human pathogens. Humus particularly plays an important role in creating fertility in soils as it binds soil and makes it stable and porous and increases water holding capacity. Humus is of particular value and importance in dry-lands and tropical lands. Humus not only provides micronutrients but by preventing their leaching it can also bind down elements like aluminum.[22]

Compost/manure includes organic wastes and these are thus re-cycled and fully harnessed. A reference has been made earlier to use of green manuring for which a wide variety of green manure species are available world-wide. This takes the form of alley cropping, relay cropping, live mulching, shaded green manuring and more importantly use of azolla and blue green algae which of late have gained wide acceptance and application.

In the USA a very wide range of organic fertilizers and soil amendments are available commercially and one can literally pick and choose to suit local needs. These include rock powders and other mineral deposits. According to experienced farmers it is possible to eliminate a lot of use of off-farm fertilizers once the soil is put in balance using rock powders and composts and this could lead to self-sustaining mechanisms. For organic farming, only organic soil amendments and fertilizers can be used and these are derived from living organisms. Organic residues and green manures are all part of nitrogen cycling. Widespread use is also made of various animal manures including cattle, poultry, turkeys, horses, sheep and hogs.[23] Oilseed meals are also used especially cottonseed meal. Apart from this, use is made of marine products including fish waste, shellfish waste and kelp/ seaweed.

In some cropping systems use is also made of chitin especially since it has been found to suppress root-knot and plant-parasitic nematodes. However, one disadvantage has been recorded —a product formed during its decomposition in soil has been found to be phytotoxic for some crop species.

An attempt has been made to pinpoint and highlight briefly the wide range of options and technologies and inputs available to the organic farmers world-wide. This is in addition to a very extensive range of indigenous materials and practices that could be harnessed, some of which are all but forgotten although these are being revived in many places. However, one thing clearly emerges—namely that organic farming as compared to present day conventional or chemical farming, is far more complex and demanding on the farmer, which really ends up in the active involvement of entire farm families. This has been brought out by pioneers and leaders like Fukuoka Masanobu in Japan Charolette Mitchel in UK, Enid Wonnacot in USA, Bhaskar Save and Narayan Reddy of India amongst many others.[24,25]

Under IPM a number of pest problems and their management has been referred to and same principles apply to the practitioners of organic farming. Generally speaking pest problems indicate imbalances in the adopted farming system. For instance excess nitrogen attracts aphids. In some cases such as late blight on tomatoes this arises from a combination of factors.

Broadly speaking, experienced farmers face fewer prob-

lems. In this connection attention is drawn to the excellent information provided in Real Dirt publication highlighting various plant pathogens and manner in which these were tackled by growers on their farms in USA. Information provided also covers the green- house pests.[4] By and large weeds which really means any unwanted plants that interfere with human activities, present a serious problem in farming world-wide and require considerable ingenuity and experience in controlling. Weeds, as has been pointed out earlier, tend to reduce soil moisture and nutrients and therefore yields.

They require high labour and other costs to control. Apart from providing pest habitats, they can also poison or irritate both livestock and humans and in the USA alone some 700 such plants are recognized to act as poisons or allergins.[26]

Rotations, use of nurse crops and spacing—all help to control weeds. These should not be allowed to go on seed. In fact the occurrence of weeds generally indicates the type of soil. Appearance of Shepherds purse for example indicates saline soil, whereas Mosses indicates water-logged soils and Canada thistle a heavy clay soil and so on. A table of 31 such weeds and corresponding soil conditions has been compiled in *Soul of Soil* by Grace Gershuny and Joseph Smillie of Mac Donald University, Quebec, Canada, 1986. Practical ways of identification, control methods and uprooting by cultivation has also been described. The use of flame weeders has also been attempted, although this is a bit costly. Mulching, polarisation, mowing, allelopathy and biological control are other tools available to meet various situations. Pest control in vegetables and fruit crops needs a different type of emphasis and methodology.

The role of good plant nutrition as a factor in disease resistance has now been fully recognised. It seems clear that there is an interconnection of one or the other nutrient imbalance with particular diseases. The same is true of soil health, organic matter content, drainage and friability. Some of these ideas may seem nebulous but piecing together scanty information, it does seems that there are positive linkages. Equally important is the selection and choice of cultivator as also cultural techniques which have been shown to have a distinct effect on plant resistance to pathogens.[27]

Six case studies brought out from six successful organic animal farms in Northeast of USA give hope not only for the present but also for future directions.[28]

These relate to William and Kate Kruesis' (case study 1) 113 acre Organic Sheep farm at Chester, New Jersey. The Kruesis' have been running this family sheep farm since 1962 and have described various fertility, health, feed and marketing problems encountered by them and how these have been successfully tackled.

Yet another case study is that of the Rawson's family at Barre, Massachusetts, who during 1991 raised 250 turkeys, 600 meat chickens, 65 ducks, 250 layers and 60 geese. Of the 55 acres, 12 are used for gardens, orchards and grazing area for birds while the balance 43 hold woods and swampland. The nutritional ration charts and details of feeds for turkey chicken have been provided.[25]

Scott on the other hand has leased out 125 acres out of his 248 acres and raises hay on 100 acres, corn for silage in 10 and uses 90 acres as pasture land with a herd size of 100 head of cattle for beef production.

Yet another well-known Dairy farm is that of Earl Spencer (Valley View Farm, Palatine Bridge, New York State). This is a 250 acre farm (115 of which is leased). He milks 50 Holsteins and raises another 70-80 young stock. His herd average is 20,000 lbs. a year on a grain intake of about 3,000 lbs. per cow.

The Lazors' working on their 170 acre Butterworks farm at Westfield in northern Vermont have specialised in organic yogurt, milk and cream and their herd average has been 12,000lbs. milk per cow. Lazor's 100 acres are open land and 70 wooded. Details of crops raised and feeds as also other details on herd health and marketing have been given with details.

The sixth case pertains to a biodynamic, Hawthorne Valley farm at Ghent, New York operated by a non-profit organisation in honour of founder of the biodynamic movement, Rudolf Steiner of Germany. This 400 acre farm produces organic grains, vegetables, milk, meat and eggs. They have 57 milking cows—some hogs and laying hens. Herd average is 13500 lbs. milk/cow. Details of cropping pattern used over the last 13 years, animal feeds, crop management practices marketing and economics details have been provided showing a gross income of US$167,000 and a net income of US$90,650 (before payroll expenses). Apart

from the above 6 case studies, Ms. Enid Wonnacot, has provided deep insight into the many challenges and successes of marketing and need for diversification to make organic farming into, holistic family ventures.[29] Brief details of some 30 organic ventures in the Northeastern States of USA have been highlighted in this valuable publication covering organic apples to potatoes and herbs.

Mention may be made here of two interesting developments at the University of California, Santa Cruz, towards the promotion of organic farming. One relates to growing commercial and special potato varieties, organically. This involved the use of compost and manure, fairly close spacing, raised beds and overhead watering. Potato as we may recall is grown in 130 countries which except for maize is more than any other crop. It grows from sea level upto 13000 feet and its' edible dry matter is higher than total fish and meat consumed world-wide. It is also high in vitamin C and potassium, high in protein and is fat free. Its yields of over 10,000 lbs. per acre even in fairly marginal lands is another key factor.

A fertilizer programme has also been developed at the University of California SANTA Cruz, using cottonseed meal, bone meal, greens and kelp meal. In this system, emphasis is on the use of quality seeds. The key to pest management relied upon is to ensure an extremely vigorous, well-fertilized crop, growing aggressively as it were. This is based on a well-realised finding that pests and diseases thrive on weak, sickly plants. This is also expected to encourage a diverse, balanced insect community, specially of flowering plants, which would provide a habitat for beneficial insects.

It is considered equally important to change the cropping pattern each year and it helps if potato crop is not taken from the same plot for atleast 2 years.[30] A more recent Report gives comparative, replicated details of strawberry cultivation by organic and conventional methods.[31] Although the yields in organic farming were lower by about 28 per cent in the 3rd year of cultivation, the superior returns were more than compensated.

California produces crop worth over US$300 millions covering some 19,250 acres. Here also the key seems to be in the proper supply of plant nutrients with nutrient budgets and removal of pesticide stress in organic farming leading to a more diverse biological system especially the encouragement of

populations of beneficial nematodes, arthropods and fungi. These principles are also under application to the cultivation of organic apples.

While integrated organic farming has been promoted in many areas, concern has been expressed sometimes of the possibilities of contamination of water resources from the impact of animal agriculture. Take the example of California which in 1993 brought in over US $5.25 billions, forming about one quarter of California States' total marketing receipts from agriculture. Some 300 million animals livestock in California generates some 250 million lbs. of dry manure per day.[32,33]

California maintains approximately 1.22 million dairy cows and produces about 110 lbs. manure per day (15 lbs. solids). The poultry industry with 233 broilers produce 2.25 lb. dry manure/day which totals 530 million lb of dry manure per year. Twenty-six million egg layers produce another 636 million pounds dry manure per year, while 23.6 million turkeys in California produce 298 million lb of dry matter annually. Likewise 1 million horses in California produce about 15 lb. dry solids per day. California raises about 275,000 swine annually (1 per cent of the country) which produce about 11 lb. each, dry manure per day. One thousand pounds of live weight pigs produce some 84 lbs of manure per day This therefore calls for a strategy to ensure that animal manure, an excellent fertilizer does not turn into a pollutant and calls for a holistic and eco-system approach so that the safety of water is not affected.

Some of these concerns arising from large animal stocks has also been brought out in depth in UK by Conway and Pretty. These reports indicate the excessive linkages between the integrated animal-plant agriculture which it is feared may accentuate the drift towards global warming.[34] However, on a detailed, pragmatic analysis it would seem that while there is need for caution the fears do not seem to be justified when compared with the dangers and other serious problems created by chemical-based agriculture which have been touched upon already in the foregoing. This is particularly so considering the conservation of excessive energy alone that is possible with animal drought power and the resulting reduced demands on the fast depleting fossil fuels. Further the integrated organic farming systems now ushering seem to offer many new possible vistas to the women to lead in the farm economy.

We have had a fairly intensive look at organic farming especially in USA, where a strong movement has come up. A part of the impact of this has also travelled to South America. In fact on account of the new demand created in the affluent countries for organic foods and fibres, some of the countries are making use of this opportunity to go in for organic foods in a big way. Example of this is in case of organic coffee from Peru,[35] Eco-Tea from India and more recently Eco-Cotton are only two illustrative instances from developing countries and by no means the only ones as has been brought out earlier.

A recent study on Cuba converting itself *en masse* to organic farming has been widely reported and commented upon highlighting how necessity can be turned into an invention. Faced with necessity for foreign exchange, food shortages, Cuba has successfully turned to organic farming and may well be in a strong position to export its' newly established know-how. AA promotes animal traction, crop and pasture rotations, soil organic inputs, biofertilisers and biopesticides. Inputs of community participation and traditional farming knowledge is helping in generating new technologies as brought out by a visiting 21 member International Scientific delegation in November 1992.[36-38]

Vermi-composting programme started in 1986 has been impressive with 172 vermicompost centres in 1992 which produced 93,000 tons of worm humus, using California Red Hybrids. Waste recycling and reforestation has also become a part of this programme resulting in 1,200,000 tons of supplementary animal food from garbage or equal to 70,000 ha of Soya cultivation or 200,000 ha of maize. Since 1985 a major thrust has been given to biological control agents resulting in a sizeable decrease in pesticide import, from US$80 million in 1991 to US$30 million in 1992. Cuban experiment has been hailed as perhaps the largest attempt at conversion from conventional chemical based farming to organic or near-organic farming in human history.[39]

A large and effective network of a Central Research Laboratory with 14 regional labs, more than 60 plant protection territorial stations, 27 frontier posts with diagnostic labs and 218 centres for production of biological control agents have sprung up. An effective, unique pest and disease monitoring system has been set up covering today 90 per cent of entire

agriculture in Cuba.

It appears Cuba's inspiration came from the devastating failure of it's sugar crop sometime in 1970 when its President called it Venceremos, the year of victory. This seems to be not very different from what happened in Indonesia with rice failure in 1987 leading the way to banning the use and imports of some 57 pesticides and successful adoption of IPM.

There has been 53 per cent reduction in oil imports an indicator of self-reliance as is the case with steep fall in wheat and other food imports, especially zero imports of milk. These results should provide cold comfort to a many champions of conventional farming who also serve as prophets of Doom for those who may wish to switch over to organic farming. A seven person Team from PAN, comprising of representatives from Senegal, Peru, Colombia, Malaysia, the US and the UK which visited Cuba in August 1996 has returned with glowing tributes to the success of the Cuban experiment.[40] Cuba it appears may lead the world soon in organic farming with its reliance on indigenous biological control technology, green manuring and intensive organic vegetable production. In fact so great is the local confidence that an International meet on organics was organised in cuba during 1997. These developments from tiny Cuba should serve as a lesson to our policy and decision makers.[41]

Before we take up the organic farming movement in the third world, slow and disenchanting as it is, a reference will be made to a rather outstanding and non-traditional no-holds barred study from Greenpeace (Green Fields,Grey Future).[42] This has taken up EC agriculture policy and brought out in no uncertain terms the various vested interests and machinations which seem to be intent on maintaining a *status quo*. Although the Report is largely confined to the European situation and EC Policy, nevertheless it provides formidable arguments in favor of organic farming as against industrial agriculture.

In Europe as in USA in some areas due to the use of chemical fertilizers, there are mountains of organic manure to dispose off. While there is no doubt on improved yields due to use of agrochemicals over a short time span, but what needs to be considered is the long-term after-effects on account of pollution, degradation of the soil, loss of biological diversity, soil

erosion and other fallouts including depletion and destruction of water resources. Further the heavy energy inputs needed are an important cause for concern.

Nitrate levels in drinking water in Europe are already a cause for anxiety. For example 8 per cent of water supplies are beyond EC standards of 50mg/l. In Germany this level was also above for 5-6 per cent of the population. In France the picture was worse, affecting supplies of 20 per cent of the population above EC standards by 1995. A similar scenario exists for Netherlands and UK, as also Spain and Italy's Po Valley. For pesticides also, 65 per cent of all the underground water, will be higher than 0.5ug/L, the EC standard. In fact in 25 per cent of the area, the standard will be exceeded by over 10 times the EC standard. The situation is desperate as can be seen by the estimated high costs of cleaning up of drinking water resources. In UK for instance to reduce levels, to confirm to EC standards, would need 450 million pounds for 12 million consumers. It has been estimated that water bills could double by the end of the decade because of higher environmental standards.

Pesticide pollution in sea or river waters interferes with breeding season of aquatic creatures leading to defects in deep sea fish embryos in the North Sea. As is known pesticides are also a part of air pollution through drift and volatilisation after application. Some 75-90 per cent of many of the pesticides escape to and travel long distances and appear in rain, fog and air, far away from their original point of use. As a part of this vicious cycle, pesticides enter the sea, apart from run-off from the farms, from rain and through air drift of tiny dust particles and remain in the atmosphere for a long time. Pesticides like methyl bromide and carbon tetrachloride deplete the earth's protective ozone layer. Methyl bromide for instance is estimated to cause between 1/10th and 1/20th of the total ozone layer loss. Methyl bromide is about 30 times more destructive, atom for atom, than chloro fluoro carbons (CFCs) according to UNEP estimates. About 100 organo-halogen compounds are believed to be in use as pesticides and some of these are also suspected to cause ozone depletion.

Small surprise, that Pesticide Action Network, North America (PAN-NA) has set up and launched a special Anti-Methyl Bromide Campaign, seeking for a total ban on methyl bromide. This appeal has also gone to the Indian government as a part of this campaign, from an Indian NGO (Society for Citizen Con-

cerns), one of the supporters of the worldwide campaign.[43] There has been a well organised pressure against Methyl bromide which has its close chemical links with Ethylene dibromide (EDB) which has been now banned in USA and many other countries.[44] As a result of sustained effort UN agencies are now promoting alternatives to methyl bromide. A good example for emulation by concerned groups worldwide.[45, 45A]

Energy

As has been brought out earlier also, present day chemical-based agriculture has emerged as a significant consumer of non-renewable fossil fuels. Fertilizers alone account for upto 50 per cent of energy consumption in fuel. Pimentel for instance estimates that if food production doubles using present system of agriculture, 3-4 times more energy would be needed, which could only result in total drying up of fossil fuels much earlier than estimated. The food sector in OECD, from production of fertilizers to the point of food preparation is estimated to use 10-20 per cent of final energy used. Here the energy used is both fuel plus electricity including for production of inputs like agriculture-chemicals.

It has been shown that like fertilizers, energy needs for pesticide manufacture is rather high—in fact 4-5 times higher. In 1983-84, 74.5 million short tons of nitrogen were produced world-wide requiring some 32 billion gallons of diesel fuel. Inclusive of packaging, transportation and application this means 36 billion gallons of diesel fuel or about 650 million barrels.

On the other hand it is estimated that biological nitrogen fixation by legumes fixes about 88 million tons of nitrogen each year for agriculture or some 55 million tons of nitrogen fertilizer. Switching over to organic farming in Cuba has meant a dramatic change in reducing imports of petroleum by 53 per cent, chemical fertilizer by 77 per cent, pesticides by 62.5 per cent and animal feeds by 70 per cent. It is not only the manufacture of agrochemicals which required high energy but formulation, packaging, distribution and transport as also application. Some pesticides are also highly energy-intensive during manufacture. For instance for 2,4-D herbicide energy input is 36,567 BTUs/lb while for cypermethrin insecticide this is 249,518 BTUs/lb. Organochlorine pesticides require on an average about 67,000 Kcal. per Kg.of active ingredient, whereas this figure is 100,000 Kcal. per Kg. for organophosphate and carbamate insecticides

In India, in 1991-92 of the total electricity production of 28.20 million KWH., agriculture use accounted for 28.20 per cent. However details of other sources of energy (fuel) for the entire agriculture operations, including irrigation, tubewells, manufacture of agri-chemicals, tractors, transport is not readily available. Like agriculture, intensive animal production is a major consumer of energy. In USA about half the energy used in agriculture is estimated to go into the livestock sector. It is not considered economical to haul animal manure beyond 5 Km in OECD and 40-50 Km in USA.

A reference has already been made to the problem of soil erosion in industrial agriculture. The figures vary for European countries but as per EC, some 25 million ha are threatened -- an area eight times the size of the Netherlands. This means reduced production in years ahead from chemical farming.[46-49]

Loss of Habitats and Biological Diversity

In Europe about 50 per cent of all animal and plant species are in danger of extinction. The world-wide picture in many cases is even grimmer. This has been ascribed to the intensive nature of farming. For former West Germany for example, there has been a Red Data List. This indicates the extinction or endangering of 30 per cent of flowering plants and ferns, 40 per cent bird species, 50 per cent mammal species and 65 per cent of crawling and amphibian species.

In Lower Saxony, some 24 plant species had disappeared (1879-1950) and in the succeeding 30 years, more than 130 species were extinct. Consider the loss when you know that the loss of a single plant species normally coincides with the loss of 10-12 animal species. A reference has been made earlier to the pioneering work of USDA who had foreseen the pitfalls for chemical farming and had come forward to define it in 1980. This was obviously a clear case of foresight aimed at providing an insight, guidance and support to the farmers and also for providing some support by way R&D to deal with the new emergence of farming with roots in the past. These ideas no doubt had roots in the work of earlier pioneers like Sir Albert Howard and others.[50] To this movement, the 1962 Book of Rachel Carson, The Silent Spring gave a new direction as it highlighted in practical and scientific manner the dangers of chemicals. There never has been need to look back at these events. Today there are tens of thousands of certified farmers world-wide apart from literally millions of no- or low-external

input traditional farmers producing food without any agro-chemicals. As has been brought out, in India itself by necessity, almost 70 per cent of small farmers in dryland areas or hilly regions do not have the means to use agrochemical in any case.[51]

The Greenpeace study shows that from 7,500 farms with 103,000 ha. in 1987, in 1990-91 there were over 13,000 such farms with 270,000 ha. in 12 EC countries and 5 non-EC countries covering almost every country in Europe. In many of these countries, about 10 per cent of arable land was under organic farming. A fair amount of this change has taken place on account of official policies and support to farmers using biological methods and for switching over to organic farming.

One of the important attraction for farmers has been the higher nitrogen efficiency on organic farms which in effect leads to reduced nutrient leaching. For instance a Danish study shows that nitrogen surplus on chemical farms was 240 Kg/ha as against a surplus of 124 Kg/ha on organic farms. Efficiency of nitrogen (N) use was also some 25 per cent higher on the organic farms. Thus on chemical farms there was a surplus of N, on organic farms there was no such surplus in view of full utilization of organic manure.

Yield comparisons from 200 chemical, organic and biodynamic farms in Germany and results of yields on organic and chemical forms in Switzerland by and large show that yields were comparable although loaded in favour of the conventional chemical farming. On the other hand more recent results in USA as also a 3-year Dutch study and results of other organic farmers in India (to be touched upon later) conclusively show that both the systems are either at par or in fact in favor of organic farming.[52] This has also been conclusively brought out effectively by Thampan in his publication on the subject.[53] Comparative studies in the Netherlands and Switzerland also show that the financial returns on organic farms can exceed the returns on conventional, chemical based farms.

Some recent findings which should be a shot in the arm of promoters of organic food is a scientific analysis of the nutritional quality of fruits and vegetables grown organically. It is reported that the results of this important study, financed by the UK Government was suppressed by the Ministry of Agriculture, Fisheries and Food (MAFF). There has been all

along a widespread gut feeling amongst the old timers regarding the lower nutritional quality apart from the poor taste it, on foods grown on chemical inputs but there has been no clear cut scientific evidence so far. In fact in early nineties, this writer sent out a letter to several Agriculture R&D laboratories/scientific institutions in several countries including USDA in USA seeking to know if there were any such scientific studies on the subject which drew a blank.[54] This revelation by the *Living Earth and the Food Magazine*, London, assumes great importance and significance. In essence, the results of this 2-year study carried out by the Campden Food and Drink Research Association and sponsored by MAFF had shown clearly, significant nutritional differences between organic and non-organic produce with considerable variation between samples of each fruit and vegetable tested.

The results show organic apples and tomatoes richer in vitamins. Organic potatoes also were better in vitamin and mineral content. No such improvement was, however, reported in carrots and cabbages. It appears studies in Sweden 1970 had shown reduced water nitrate levels and increased vitamin C in potatoes under organic farming conditions. Rabbits and hens had also shown higher survival rates and improved fertility amongst animals reared with organic feed. In case of hens eggs, there was less of albumin and more of egg yolks.[54]

Yet another Danish study of interest, shows that amongst the organic farmers living mainly on organic foods, the men had sperm counts twice those of the national average. This study was conducted by the Department of Occupational Medicine at Aarhus, Denmark. The study showed that as against sperm cell count of 50-55 million/ml - sperms that are alive and able to fertilize an ovum, the count in those on organic foods was as high as twice the above.[54] This should interest those who are seriously concerned about serious drop in fertility in Europe where one in every six couples are experiencing infertility, with a 1/3rd of these cases ascribed to male partners' low sperm count.

We must now address ourselves to the question often posed by promoters of chemical farming who often are also the detractors of organic farming. These groups have profited from lack of togetherness of organic farmers and also taken advantage of their lack of resources to put forward their case to the

policy and decision makers.

The thrust of their theme song, which does attract sympathy specially amongst non- scientific bureaucrats is that the world will go hungry because of failure in food production or even naked because of fall in fiber production, if the world switches back to organic farming. Often pictures of starvation deaths, famines and disease outbreaks have been drawn up to muster support for their case.

In all these arguments the main point is kept in low key: That it was not the availability of food but largely the maldistribution either due to poor purchasing power or a variety of other reasons, that has largely been responsible for starvation and shortages in many parts of the world, including India.[52]

According to the Greenpeace analysis(1992), the complete or partial switch over to organic farming from the present day conventional farming may lower the yields in livestock by 10-20 per cent and in cereals by 10 per cent. However, more recent results in the USA and elsewhere are not in agreement with these interpretations and the deductions are varied. Also in these arguments an imponderable factor of both food for animal production and food for humans comes in and if cereals are not used as intensively for animal production as in European countries, there indeed would be no danger of food shortages for the human population. In other words the kind of low-level nutritional animal feeding practices as in vogue in India over centuries may offer the answer to food security for the human population.

There has been a debate on the estimates of actual food production vs estimated food production. By and large it is agreed that the estimated production figures quite often do not cover the quantum of food produced which the farmers retain for their own household use, as this does not reach the markets.[52]

A UNDP study of a survey (1992) spread over 14 countries and 4 continents and covering hundreds of farms, came to the conclusion that organic agriculture was a viable and feasible option for environmental and economic reasons in developing countries. In fact in most of the cases studied, the total output value was higher on organic farms, possibly on account of a wider mix of crops and livestock and sometimes due to higher yields. In fact organic farming seemed to be more stable and

consistent over a number of years, which goes in its favour from the point of view of both food and economic security.

A number of studies and reports including on India, Poland and Africa seem to come to the common conclusion that largely so far, the sporadic food shortages have occurred more on account of malfunctioning of marketing , distribution and often on account of shortages of storage capacities.

Wherever organic farming and related methods have taken roots, one can clearly identify the reasons and one such important reason is the laying down of standards for organic produce. These regulations in Europe by EC as in USA by the respective state level functionaries make it obligatory to market various crops and foods only after a certification by an approved authority, whose duty it is to oversee during production and manufacture. EC Regulations did not cover animal products until 1992 although these are likely to follow here as also in the USA. Organically produced milk is, however, being sold in the USA at present. Organic Regulations set minimum acceptable methods for organic foods produced at farm levels.[55]

For example synthetic fertilizers cannot be used as also synthetic pesticides. Some of the pesticide preparations like pyrethrins, sulphur, Bordeaux mixture, pheromones and Bt. are permitted in case of threat to crops. Despite this, the EC standards have been faulted on account of the inadequacy of regulations of certain farming practices and problems of implementation and enforcement. There has been a feeling that the storage and application of livestock manure needs to be regulated so that this does not serve as a source of contamination of water. Sewage sludge needs to be regulated as this often contains heavy metals like chromium, cadmium and nickel.

EC regulations are also quiet on the prevention of and use of genetically engineered products such as rBGH for increasing milk yields and for genetically engineered crops. Some of these shortcomings of EC standards, are being overcome through the efforts of some voluntary organic groups like the Soil Association in UK which has set higher and more stringent organic standards, indicating room for improvement in the EC standards. The International Federation of Organic Agriculture Movements (IFOAM) at Tholey-Theley in Germany, for example have a well-knit organisation for certification in many countries especially Germany for those who

market in EC countries.

In North East USA, organic certification started in 1977 in Vermont and New Hampshire followed by Maine, Massachusetts, Connecticut, Rhode Island, New Jersey and New Hampshire. The farmers organisations with common goals and purposes have joined hands and formed the Northeast Organic Farming Association which works in close cooperation with USDA, State Agriculture Departments and the respective Agricultural Universities. The organic movement in these States as elsewhere in USA have a strong leadership with feminine gender in the lead, giving it a foresight, determination and direction which we now have come to associate with this gender.

Patrick Holden of the Soil Association makes out a case for a strong organic certification infrastructure.[56]

Experience of organic promoters the world over clearly shows the need for inexpensive organic certification & marketing which would also protect the organic movement from unfair onslaughts. It is therefore good news that the USDA recently have dropped their move to lower the organic standards in the USA.[57]

It is equally a welcome development that the Danish railways, the Swissar have decided to go organic.[58]

A recent protest in UK against spraying of rail tracks by the British Rails which polluted fields of organic formers is also bound to have a salutary effect and help promote organic moment world-wide.[59]

We have discussed the pros and cons of organic farming, indicating its' progress in the Western world, apart from the beginnings of Natural Farming in Japan. We shall now look at some other parts of the world. Following this, progress in countries nearer home will be briefly touched on as also in India, citing a few illustrative examples which provide some hope and promise for the future.

Permaculture

This is an interesting development of a form of ecological agriculture developed in Australia by Bill Mollison with an associate David Holmgren starting 1972. The concept matured by 1981 and was taught to 26 students in 1981. According to the founder, it is basically an earth care system and had its origins in post World War- II whose roots lay, apart from military

adventurism, the nuclear bomb, in ruthless land exploitation, the arrogance of polluters and a general insensitivity to human and environmental needs.[60]

Permaculture (permanent agriculture) is the conscious design and maintenance of an agriculturally productive eco-systems with the diversity, stability and resilience of natural ecosystems. It is designed to assemble conceptual, material and strategic components in a functional pattern with a view to benefit life in all its' forms. Permaculture works with and not against nature.

Some of the ethical concerns for developing Permaculture are:

(a) Care of the Earth and provision for all life systems to continue and multiply.

(b) Care of the people–making provision for people to access resources necessary for their existence,

(c) Setting limits to population and consumption through self-control of our own needs and resources.

Permaculture has been influenced greatly by the co-operative rather than competitive nature of life as brought out by Lewis Thomas (*The Lives of a Cell*; The Viking Press Inc., 1974) and by Eugene Odum (*Fundamentals of Ecology*, W B Saunders, Toronto, 1971) and has its share of the Principles of whole-system energy flows enunciated by J.E. Lovelock (*Gaia: A new look at life on Earth*; Oxford University Press, 1979) who has advanced the Gaia hypothesis or philosophy which links science and tribal beliefs.[60] Gaia looks at the Earth and the Universe as a thought process—self-regulating, self-constructed and actively adjusting to regulate disturbances which makes life possible. This is basically an alternative—based on the Aboriginal tribes people of Australia to whom life is a totality- neither created nor-destroyed.

Design is the keyword in permaculture—design in landscape, social and conceptual systems and design also in space and time. It also centres around basic respect for all life forms, an essential ethic for all people.[61] Figures with explanatory legends broadly outline what transition to permaculture from the contemporary western agriculture in effect entails and means.

The following four broad set of ethics govern permaculture:

a) Implacable and uncompromising opposition to disturbance

of natural forests where most species are still in balance,

b) Vigorous rehabilitation of degraded and damaged natural systems to stable states.

c) Establishment of plant systems for our own use on the least amount of land we can use for our existence.

d) establishment of plant and animal refuge for rare threatened species. Permaculture (PC) has relied on simple down to earth inexpensive indigenous type of technologies which are basically dependent on sound scientific knowledge combined with deep insight. There is hardly any aspect of farming including farm housing which has not been covered. It covers climatic factors, trees and their role in energy transactions, water, soils and earthworks . It also covers the humid tropics, the dryland strategies, humid cool to cold climates as also animals and aquaculture.

Permaculture has made ambitious forays not only on social problems but aims to work towards an alternative global nation as a part of its philosophy of equitable distribution and concern for the disadvantaged through various strategies including decentralised self-sufficiency and self-reliance. In the plan of action and activities for instance in the humid tropics, the systems created cover production plans, tropical forests with trees at different levels and handling of different types of tropical soils. The use of different mulches, earth shaping, house design, the terrace system, grain storage system, earth sheltered hurricane houses and hurricane gardens also received full consideration.

PC also deals with elements of a total design for a garden. Designs have also been made to cover pathside greens, a venue cropping barrier plants, garden barriers, animal barriers, wind breaks and erosion control. It has evolved and added least-path layouts to the Home Garden designs in Taiwan and Philippines which have been termed *Gangammas' Mandala,* after one of the Karnataka PC graduates.[60] Avenue cropping is yet another area of specialisation under PC. It has aimed to evolve a system of integrated land management and a village complex for the humid tropics and also attempted to evolve a polyculture of which a set up in Nigeria is an example. Similar plans have been evolved in case of palm dominated areas apart from rehabilitation or pioneering systems evolved in respect of grasslands.

These are just a few examples to illustrate the wide range and scope of PC which has gained considerable acceptance globally. Amongst many other attributes and philosophies PC considers itself as an investment and has emerged to face the problems posed by environmental deterioration, pollution, extinction of natural systems and species and climatic changes. It is also concerned with socio-political and economic concerns, including human liberties, employment and last but not the least misdirection of research and scientific thrusts including the imposition of intellectual property rights with special reference to seeds and agricultural bio-technology.

Permaculture appears to have come of age. It's three building blocks are natural ecosystems, traditional farming and building methods and thirdly modern science and technology. It is another name for agro-ecology and involves conscious design and maintenance of local ecosystems to ensure diversity, stability and resilience, to provide sustainable food production, housing and domestic energy. In fact it is largely a replication of what self-sufficient peasants have done for generations-traditions which in effect are really the distillation of trial and error over the centuries—a source of accumulated wisdom and experience.

Under permaculture, the existing climate and microclimates, although important, can be modified by the patterns in which bushes and trees are planted. Different ecosystems generally overlap at these meeting points, quite often leading to doubling the number of species and greatly increasing the biological productivity. Tidal estuaries are perhaps the best known example. While in the industrial agriculture the soil determines the type of farming, but PC uses well tried out methods for making top soil fertile. PC emphasises that every landscape can produce good food in abundance. PC in ideal conditions is more productive than AA although it requires no external inputs.

Biodynamic agriculture

Yet another method of non-chemical farming, which has a good deal of flavour of spirituality and links with cosmic rhythms and constellations is the biodynamic (BD) method.

It was originated in 1923 by Rudolf Steiner an Austrian philosopher- scientist. Incidentally he had close links with Annie Besant, the founder of the Theosophical Society in

India.[62]

The basis of this method was the realisation of the importance of various trace minerals which serve as biocatalysts of enzymes, growth hormones and other energy reactions for proper physiological functioning. These basic concepts over the years resulted in the evolution of 8 preparations referred to as 500 series preparations starting 500 - 507.

These preparations are basically used for treating manure and composts. In addition BD method relies on crop rotation, use of leguminous crops, cover crops and green manuring. BD also relies on the entire environment of a farm away from polluted air of industrial nature and other city related forms of fossil fuels. BD method relies on proper building of soil through use of proper compost, which also means micro-life. Use of BD compost preparations or BD starter is aimed at creating soil with a good humus. This is followed by suitable crop rotations and cover crops, green manure, mulching, apart from use of improved soil cultivation practices and lastly environmental control including wind protection, drainage and control of the water resources. Preparation 500 is prepared using dung from lactating cows and the horns of the cows while preparation 501 is a finely ground silica(quartz).

The first preparation takes some 6 months to prepare start ascending moon days in September - October. Same is the case with Preparation 501. Preparations 502 -507 are based on those herbs/plant material which were identified by Steiner which had the particular trace elements in adequate quantities for addition to the soil. The planting calendar for BD method is of special importance as it takes into account astronomical and scientific factors, including sidereal and synodic relationship between the earth, sun and the moon.[63] This also takes account of moon rhythms which guide planting and sowing operations. There is a long list of Dos and Donts' to be followed during full moon, new moon and moon and saturn in opposition which is considered a rhythm occurring every 28 days. There is likewise a calendar for activities to be undertaken either with the descending period or the ascending period of the moon. Care is also taken to follow the planet position in selecting various jobs like weed and insect or rodent control .

A number of success stories of BD method in New Zealand and Australia, where this method has developed a sizable following as also to a lesser degree in USA have been recorded. Some of these farms are as large as 300 ha with mixed animal and crop husbandry (Ian Henderson, Milmore Darwin, NZ) or orchards and gardens raising vegetables. Likewise herbs and greens are being grown for instance near Apollo Bay, Victoria, Australia on a 5 acre land. At a BD farm in Eureka, northern NSW, Australia yields of nuts increased from 27 tons to 57 tons after switch over from chemical to BD farming. A study by University of New England (Northern Rivers) Australia, which compared the chemical and physical properties of soils on neighbouring BD and conventional Macadamia plantations in the Lismore area clearly established the overall superiority of BD soils in terms of moisture and levels of calcium and phosphorus. Most important of all, the humus levels at the biodynamic orchard were surprisingly high.

The BD method has recently been introduced at Indore in 1993, surprisingly at the same Government farm where Sir Albert Howard in 1930s made history through his compositing methods (called the Indore Method).[64] While it is too early to say how this system will take shape, considering the slow progress witnessed in the country in case of permaculture which was introduced in Andhra Pradesh sometime in the early eighties, one can only be reflective on the subject. More about this when we touch on the constraints facing the organic farming movement.

We have so far touched on beginnings of AA/SA in various places, including Sir Albert Howard's Indore Compost Method, and the development of other farming methods including organic farming, ecological farming, permaculture, biodynamic farming as also IPM. We shall now have a look at the developments in Asian countries, starting with India.

A reference has already been made to the 3 year comparative Dutch study on organic vs conventional farming in India which perhaps is the only one of its' kind carried out in an authentic, systematic and scientific manner. This may be due to an extent not only to the background of those involved but also obviously to the availability of considerable resources needed for such studies.

It appears the Department of Science and Technology was the first to bring out in June 1987 an incisive Status Report

on Pesticide Residues *vis-a-vis* consumer protection for which a group had been set up under their programme of Consumer Protection through science and technology.[65] This report obviously went beyond its' narrow mandate of looking at pesticide residues in food and brought into focus the related enviro-health dangers and touched on the need for alternatives in its recommendations. Of special interest was the inclusion of the Ottawa Declaration of June 5, 1986 of prominent academic environmentalists which had made a clarion call for a break from developing new agricultural systems fundamentally different from those promoted over the past 50 years. The declaration leaves no doubt that the use of pesticides in agriculture was the real cause for this concern. Following this land-mark Report which indirectly had the approval of the Government, the DST funded a meeting of the National Core Group meeting on Pesticides: Problems and Alternatives, in February 1989.

The Core Group not only supported the recommendations contained in the above 1987 report but came out with clear and concise recommendations with cogent reasoning for moving towards the goal of Ecological farming.[66] Perhaps the first concrete attempt at putting together available information on organic farming was the one brought out in the *Ecological Visions* (1989), a joint publication of the Classic Books and the Development Research, Communications and Services Centre (DRCSC) both located at Calcutta. [67] This publication had given details of some 10 individuals engaged in organic farming in the country. Unfortunately as continues to be the situation even at the time of writing this, the description lacks scientific data and information which could be easily replicated or verified. Even a more serious lacuna is the absence of controlled comparative field trials of organic vs conventional farming with economic results. As we will see later to an extent this lacuna has been overcome recently at the Bhaskar Save Farm, Valsad and to some degree extent at the Narayan Reddy Farm near Bangalore.

This publication also gave what it calls a Networking Guide for Ecological Agriculture consisting of 65 names and addresses of individuals and organisations (including 7 overseas) engaged in this work or were supportive of this system of farming. Following these pioneering efforts, several reports/ writings have appeared and there has been a sustained spate of seminars/workshops/conferences and these continue. One

such, organized by the United Planters Association(UPASI) took place at Kottayam, Kerala in September, 1995 with an emphasis on organic farming for plantation crops. There have been more such meetings since then but the problems continue as before, possibly on account of lack of official support.

Of special interest is the special issue of CAPART's, *Moving Technology* (1990) devoted to the biological control of pests.[68] This was followed in February 1991 with a special issue on natural farming techniques, on various pros and cons, including report of visits to some organic farms in Madhya Pradesh.[69]

South-South Solidaritys' Agriculture and People Report (1992) is yet another excellent publication touching on eco-health hazards of chemical-based agriculture and possible alternatives.[70]

The report cites success stories from India and across the world in support of its' case for the adoption of alternative agriculture. The report also gives a list of some 580 addresses of farmers/organisations/Institutions involved in organic farming or promoting it or engaged in R&D work from 51 countries including India. While 356 of these were from overseas, 227 were from India. It must be clarified that this Directory was in no way complete as clearly stated by the writers, either for the various countries or for India and was only illustrative and possibly a beginning in the right direction.

The Report had classified these entries into 4 categories:

- A- individuals/institutions engaged in sustainable agricul ture
- B- those engaged in promotion and advocacy
- C- those engaged in R&D in agriculture and
- D- those engaged in R&D in public health aspects

The report has also given brief accounts of success stories from India, Thailand, Philippines, Indonesia and some South American and African countries to bring home not only the need, but the excellent scope for successful promotion of ecological farming.

Some examples of practical experience with organic farming in some of the Asian countries, including India will be presented here, to once again indicate the vast scope and

potential that lies untapped for a variety of reasons in the absence of official policies and support.

Perhaps one of the most successful farm which adopted natural farming (no till of Fukuoka) after going through the intermediate stage of organic farming is that of Bhaskar Save. Located near the sea coast at Umbergaon (District Valsad) in South Gujarat, the 14.5 acre Kalpavraksha farm has been successfully running for nearly 35 years.

Save has developed a few cardinal principles for his method of natural farming on his mainly orchard farm. Intensive use has been made of earthworms which obviate the need for tilling. For this he has created the right environment which really means dark, moist, well aerated surroundings with an abundant supply of organic matter. These conditions are sought to be provided through use of organic fertilizer and mulching. Ground cover is provided by the cultivation of vegetables, legumes and also allowing weeds to grow undisturbed and by providing shading. At Save Farm, purchase of commercial earthworm or vermicompost is not favoured as they had experienced financial losses. Use is made of 3 types of earthworms–one which is active on the soil surface, another type which is active below soil surface and the third type which burrow vertically into the soil, thereby creating favourable conditions of channels for drainage, aeration and thus help root growth.[71]

With proper irrigation, earthworms have been found to remain active throughout the year, even through any long dry season. Drip irrigation on the other hand has not been found to be as effective and supportive of earthworm activity, so essential in Saves' natural farming method. In addition to organic manure which is used up fast by earthworms, use is made of farm crop residues, leaves, weeds and biogas slurry.[72] Off-the-farm inputs used are about 1.5 ton of organic manure mostly poultry and cow waste, about 3 tons of municipal garbage and some 14 tons of silt from the bottom of a nearby pond. Save has developed the platform and trench methods which helps keep both water and nutrients away from the plants to enrich soil. This keeps water and manure some 16 feet away. This also reduces the need for water to about 25-30 per cent of 140 litres required in a year in the conventional method.

The manure is actually food for soil life which makes humus, NPK, micronutrients and other vital needs. This system develops strong roots. The trenches are well-mulched leading

to high earthworm activity, rapid water abosrption and reduced losses on account of evaporation. Trenches also serve to drain excess water during rains. The Save system relies on growing a wide range of short-life e.g. vegetables, medium life (e.g. banana) and long-life (e.g. coconut) plants, especially initially when developing an orchard.

The important point is that well-nourished plants resist pests well, apart from the abundance of parasites and predators as a natural biological control. Spiders, grass hoppers, red ants, frogs and birds like owls are considered farmer-friendly, as these eat away harmful pests and rodents. Plants like sweet neem, curry leaves, *Murrayu sp.* and *tulsi*, also help as pest-repellents. In addition use is made of a mixture of one part of cow urine with 8 parts water for spraying on the plants as also a tobacco decoction.

Mulching denies sunlight to weeds thereby destroying them. Save has innovated a novel method of planting coconut trees which has meant 84 trees per acre as against the traditional 70. This method also has other fringe benefits of growing extra vegetables/pulses thereby improving returns. Net profit on a single banana tree has resulted in a net profit of Rs.154.00 per season by the Save method as against Rs 26.25 by the conventional method. Part of this advantage is on account of better sale price of organic banana (Rs.2.50/kg) as against Rs.1.75/kg for conventional banana .

There is unsatisfied demand for these bananas and other organic farm products, which are being marketed in Central Bombay by *Vardhaman Sansmits' Dham.* Incidentally a pioneering marketing outlet was started several years earlier by an enterprising young lady (Kavita Mukhi) in the fashionable, affluent, Malabar Hill area of Bombay city. In fact, on analysis it will be found that lack of effective marketing is one of the most serious bottlenecks which has prevented the growth of organic farming in the country unlike the situation in the western world.

Of Saves' 14 acres, 10 are under tree crops, 2 are used as a coconut nursery, 2 acres for crops like rice, pulses and vegetables mainly for own use. There are about 350 chikoo trees and same number of coconut trees. Yearly, Save sells about 20,000 coconut saplings. In between the main chikoo and coconut trees smaller numbers of bananas, papaya, mango, jack-fruit, guava, arecanut, custard apple, kala jamun, white

jambul, drum-stick, curry leaves, pepper, passion fruit and a few other plants have been raised. Yet another innovation has been the development and use of a croton plant which serves as an indicator plant, indicating the need for water, when it shows signs of wilting.

Save Farm is also maintaining 2 cows, a bull and 2 calves. Annual income from the Farm is estimated at over Rs. 5 lakhs against an annual expenditure of Rs. 50,000/- . Ninety percent of the revenue is from chikoo and coconuts and the rest from bananas, curry leaves and some honey.

Incidentally coconut trees earlier used to yield 200-250 fruits per year which has gone upto 360-400 after turning organic. The average yield from conventional cropping in Kerala is estimated to be 200 coconuts per tree. This apart the taste of organic cocnuts and the flavour are considered a lot better.

This briefly is the outstanding success story of Bhaskhar Save which is there for all to see and should inspire confidence in the economic viability of the ecological system of farming provided there is self confidence and an open mind which helps learning from mistakes and errors and experience of others as well.[72]

Yet another excellent success story of ecological farming is centred around Mr. Narayan Reddy. Located at Soranhunise, near Varathur Village close to Whitefield Railway Station, not far from the busy Bangalore airport is this 9 acre farm. Reddy had started off in 1975 on a 1.5 acre land following conventional chemical farming which brought him many awards and prizes for outstanding yields. However, by 1979 he became aware that the soil had been depleted beyond repair which drove him into organic farming. And this was the turning point for him to embark in 1980 on organic/natural combination which resulted initially to drop of some 60 per cent in his yields. However, through patience and perseverance he overcame his problems in 3-4 more years.

Reddy grows a wide variety of crops including soybeans, brinjals, tomato, potato, sweet potato, varieties of gourd, grams, cardamoms and pepper which he grows around perennial trees. Reddy has also now introduced coffee plants and teak wood trees, one each for 4 coconut trees. Teak's tender leaves serve as a green manure. Mulberry trees are grown in circles of 6 such

trees with a compost pit in the middle with water coming from drip irrigation.[73] Leguminous crotolaria is also grown in plenty as this serves as a rich fodder for 11 cows which yield about 22 litres of milk each day. The dung and urine are used as manure as also for a biogas plant. The farm has about 200 coconut trees with a yield of 120 nuts per tree.

Reddy has 200 guava trees in addition to 130 chikoo trees. Many other trees have also been planted in addition to a number of papaya trees. Leaves of datura, neem, oleander etc., are used as biocides apart from urine and dung. Pongania, jack fruit, tamarind and neem amongst other trees are highly valued at the farm, as these provide wood, fruit, honey, medicines, pesticides, biomass and fodder. In addition they serve as wind breakers and help in water and soil conservation [73] This farmer has also innovated the compost heap, about 4 feet high, six feet wide with a variable length depending on the need. This takes 70-90 days of preparation and is different from the usual pit method of compost making. The farmer makes use of earthworms and weeds.

Reddy, unlike many organic farmers has no hiccups regarding use of hybrid crops or cattle or poultry. The farm also has a fish pond -35′ x 25′ in size and 10 feet deep which annually fetches Rs.5000 to 6000. The entire system has been made self-sustaining. Reddys' method is also 10 times more labor intensive than chemical farming - an added attraction in the country. After feeding and taking care of his family needs of food and clothing, Reddy nets Rs.70 to 80 thousands per year, figures which have been verified in a study undertaken by the Institute of Social and Economic Change, Bangalore.

The above 2 examples are perhaps the ones that have attempted to bring in an element of economics and account-keeping which has been widely accepted in the country.[73]

Another successful 10-acre organic farm unit that has come up during the last 5 years is that of Purshattom Rao in the village Theerthahalli (Shimoga District.) in Karnataka who has switched over from conventional farming. Essentially there is mixed cropping of coffee, vanilla, coconuts, mulberry, cardamom, cocoa and arecanut on this farm, products for which there is a ready market. The farm was also involved in beekeeping apart from 8 farm cattle. Rao has developed indigenous biofertilisers apart from the use of rock phosphate in colloidal farm. Growing vidanga, alangion and stinging nettle serves as catalysts for bacterial

activity and results in improved soil fertility. Use of some plants like adhathods is advocated on account of the beneficial hormonal effect.[7A]

At Dahanu, Maharashtra, Poonam Chand Baphna has been practicing organic farming in his 25 acre orchard for several years. From the early sixties the farm was growing mainly chikoo, mango, coconut, custard apples and some strawberries, falsa and cherry. Litchi were also grown using high doses of agrochemical. However the orchard was going down in returns and quality of fruits. Sometime in 1979 there was a switch over to organic farming with spectacular results after 1984 which continue. The farm swears by earthworms and drip irrigation. Baphna also uses 4-5Kg. of ayurveda fertilizer as a soil conditioner which is an off the farm input. This is a mix of herbal and plant matter. Of late, Subabul trees have also been introduced which help through nitrogen fixation.

However the economics of the Farm before and after have not been revealed nor the figures in terms of yields-a common denominator in our organic farms which has enabled the promoters of chemical farming to denigrate the organic movement.[75]

Another widely known organic farm is the Gloria Farm at Auroville, Pondicherry with 40 ha. land running successfully since the last 15 years. They are growing rice with a yield of 6 tons/ ha. and maintaining a herd of 250 cows with 800L milk output per day. All the feeds are provided by the farm, which also produces on an average 250 kg. of vegetables per day. Pest control is exercised through ducks, botanical pesticides such as neem and other herbs.[76] Although this perhaps is the largest single organic farm in the country, unfortunately it has not been possible to obtain figures of yields or profits/loss on the farm as has been the case with the first 2 farms of Save and Reddy described earlier.

There are a few other organic farmers in the country but almost all of these suffer from one major problem which does not encourage one to describe these in any detail—namely the lack of documented information on the economics of these farms *per se* or preferably as compared to the conventional farmers or even their own assessments of inputs and outputs and net returns from the farms. Nevertheless some of these have been doing pioneering work and can be referred to as trail blazers. List of all the organic farmers was compiled in the Agriculture and

People report of the South -South Solidarity, New Delhi[70](l.c.)

SEVA, under Ashok Ghosh has also initiated comparative trials on Natural Agriculture, low input and high input agriculture through their Vikas Kendra located at Atghara, North, 24 Praganas in West Bengal. Their average yields (1991-92) for grains of Brassica, Lentil and wheat show lower yields under Natural farming as compared to low and high external input system. This could be expected during first 3 years or so of switch over from conventional to ecological farming.[77] Kalpavriksh, New Delhi with Ashish Kothari in the lead have been probing the area of Ecological farming & alternatives to present chemical farming & their conclusions have been presented in their unpublished publications. [78,79,80] However, what is important is that a beginning has been made to study under controlled conditions. It is thus clear that while there is considerable awakening and awareness about the need and scope for organic farming, in actual practice this has not been taken up by the affluent farmers.

This does seem paradoxical considering that since 1984 beginning with a seminar on organic farming organised by Samvardhan, of Ahmedabad at Wardha , there have been a number of seminars around the country on the subject of pesticides and alternatives including ecological farming. As per our information some 15 such meetings have been organised nationally at various locations with many pious resolutions without almost any exception. We will have a quick look at some of the innovative work attempted in the country which if extended is likely to help adoption of ecological farming.

One of the innovative examples in this direction is the modified anaerobic composting system developed through observation, trial and error by K.T. Thomas located at Palai in Kottayam District of Kerala. Named as modified anaerobic composting system (MACS) this has been used successfully since 1986 as a compost-cum-biogas (methane) system. The main advantage seems to be that there is no volume reduction in this process. The capacity of one filling is about 80-100 tons. of finished compost and all waste from pineapples, cow-dung/urine/poultry droppings/ weeds/kitchen waste are all utilised. In addition the system yields gas from the composite pit which is 21′ x 16′ x17′ depth and takes about a year to fill but matures in about 30 days. It is emptied all at one time and used. Thomas gives no details of the nutrient composition of the inputs or the output but thinks that such community level systems would work. The figures for

setting up and the costs as presented are believed to be cost-effective apart from promoting organic farming in this predominantly rubber plantation area.[81]

A farmer G. Appaji located in the Guntur district of Andhra Pradesh, India with encouragement from the local ICRISAT scientists, stopped the use of pesticides on groundnuts which was being used against a pod-boring caterpillar *Helicoverpa armigera*. This resulted in yields higher than those on sprayed fields. This has led to the farmer encouraging birds who spread insect pathogens in their droppings and feed on insects and their larvae. Within a season, 400 ha. of groundnuts of other farmers also had switched over to this method, saving collectively about Rs.1 million in higher yields and Rs.2500 on pesticides on each acre due to savings on pesticides which they spent before.[82]

In the village Jakhda of Dholka Taluka which is a semi-arid region in Gujurat, normally, Farm Yard Manure (FYM) was dumped for about a year before use on the farms. A new system, the micro-nutrient fortified compost (MFC) from the FYM has been developed successfully by the Institute for Studies and Transformation (IST), Ahmedabad, Gujurat and is in use since 1987. The idea is to add to FYM, micronutrients in controlled quantities—such as gypsum, iron sulphate, zinc sulphate, ammonium molybdate. These supply essential needs of soil microorganisms for instance for nitrogen fixation. Comparative trials with FYM and MFC with chemical fertilizers leaves no doubt that the MFC was indeed cost-effective with tremendous improvements in yields. This apart the resistance to pests and drought also appeared to improve considerably.[83]

The comparative results of 2 farms in Bharuch district of South Gujurat—one 9.1 ha. using conventional method (CM) and the other 35 ha. ecological farm (EF) in the same village convincingly shows the superiority of the EF method. This has been demonstrated through determination of nutrient balances, NPK, in kg/ha/year on the 2 farms which showed a much higher per cent efficiency in the EF as compared to the CM especially in respect of P&K components. The yields in EF were lower by 20-25 per cent. However, this was more than compensated by sale of seeds which are in demand. The CM grew paddy, cotton, sugarcane, wheat, gram, safflower, rajko (a fodder crop) apart from sesbania and pigeonpea from his cattle herd of 11. The EF grew sesbania, safflower paddy, mulberry for silkworm raising, soybean, peanut, pigeonpea and Rajko. It has a herd of 37 cattle.

EF Farm has a Biogas plant. Both the CM and the EF go in for some limited off-farm organic inputs.[84]

An enterprising agriculture graduate-farmer, not a very common phenomenon in the country, has developed a method for compost making from rice mill wastes working at the Varanashi Farms, at Adyanakda (Karnataka).[85] Varanashi Krishna Moorthy has also determined the nutrient status of his raw material, paddy dust, chaffy grains and husk before and after compost making at the end of 6 months.

The highest results were obtained for N, P_2O_5 and K_2O (0.63 per cent, 0.60 per cent, 0.36 per cent respectively) when a small quantity (0.004 per cent) urea was added. Not only there was improvement in the NPK values but there was helpful destruction of weed seeds in the process. Nutrient content of coffee fruit skin waste compost was average of 1.48 per cent(N), 0.35 per cent(P_2O_5)and 3.3 per cent potassium oxide (K_2O). Yet another promising innovation at the same Farm has been use of coconut pith an industrial waste as manure. The pith attracted attention since it is a good source of potash. Recycling agro-industrial waste has emerged as the main thrust of this work. Use was made of *Pleurotus sajor-cajjuto* for degrading pith. Comparisons of this pith manure was made with 2 other conventional organic manures from biogas slurry and forest leaf compost on the growth of cashewnut seedbugs. The results showed that the 3 manures were equally good. The trials were therefore extended to arecanut, cococa, cashew and teak seedbugs at the stage of planting in the field. The performance evaluated at the end of one year was found to be comparable. A field trial on the effect of pith manure on the yield of cocoa showed a marked improvement in yield from pith manure as compared to the control.

Varanashi Research Foundation was set up in 1994 with clearly defined short term and long term objectives with emphasis on eco-friendly techniques and for developing low cost technologies covering productivity, high quality seed and seedlings for rural reconstruction and improvement of quality of life, according to reports thriving and engaged in down to earth problem solving R&D. The emphasis of work in hand is development of organic manures from agrochemical wastes with an eye and emphasis on quality control and standards. Organic farming technologies are being developed and streamlined in crops like arecanut, coffee, cocoa, coconut amongst other plantation crops

including cashewnut. Recycling of organic wastes such as fruit skin, husk, coir pith, coffee wastes apart from work on use of biological pesticides on coffee berries borer has also been undertaken.[85,86,87]

Yet another innovative farmer, N.Rajendran from Chitthar village, Periyar District of Tamil Nadu has developed simple technology for the mass production of Trichogramma parasites for use against internode borer attacks in sugar cane. With an investment of Rs.65,000, on the establishment of his laboratory setup, the entrepreneur farmer, himself engaged in sugarcane farming, could easily earn Rs.75,000/- for producing 5000 cc of the parasite. The above farmer had received initial training from T.N. Agriculture University at Coimbatore which has emerged as the leading centre on R&D on biological control apart from its Pilot scale commercial production of pest control biological agents. This University has been getting support for this work from the Department of Biotechnology of the Central Government.[88]

We will now briefly touch on some examples of organic movement in some other countries.

Ecological Farming in Nepal

Beginning in 1986, the Institute for Sustainable Agriculture, Nepal (INSAN) under the leadership of Badri N. Dahal has set up three Permaculture Demonstration and Model Farms (PCD) in the eastern Terai, mid-Hills and Kathmandu, close to the capital. These are multi-purpose and multi-dimensional Farms for R&D, Demonstration, Training, out-reach programmes and for providing consultancy including provision of seeds, saplings etc. to farmers.[89] While using permaculture as a base, it is receptive to other systems particularly that of Fukuoka. INSAN setup has done some pioneering work in creating a sound base for ecological farming in Nepal. However, it also has interests and involvement in other indigenous developmental activities ranging from low-cost building technology, energy systems and low cost rain water harvesting and storage. No doubt these are related activities though major tasks by themselves.

INSAN's PCD farms have identified and introduced a wide range of indigenous fuelwood species, fodders including grasses and nitrogen-fixing plants. For instance at Amaduva PCD Farm a wide variety of fruit and nut trees/bushes have been introduced—a range which is truly tantalizing—ranging from

passion fruit to pomegranate. A range of vegetables in addition to black pepper and betelvine are a part of this collection. At least 30 plant species have been planted for development as live fences and wind breaks. Some 10 of these are leguminous in nature. Likewise at the Kiratichhap PCD Farm, there is a wide variety of fruit/nut trees. The farm also has specialized in citrus plants apart from coffee and cardamom. In addition there are many fodder plants, fuelwood and bamboo apart from Rhododendrons, the national flower of the country. Gund plant used for mats and Nigalo used for baskets have also not been lost sight of. The PCD Farm at Kiratichhap specializes in animals with goats in the forefront.

In a paper circulated at the Pesticide Seminar at the Indian Agriculture Research Institute New Delhi in March 1993 an interesting paper on pest control was circulated by Mike Feingold who had spent some time in Nepal. Apart from touching on tips for biological control methods a number of intercropping patterns based on successful scientific trials for 16 crops had been listed obviously aimed at the reduction and control of pests in the process.[90] Of special interest was a list of 31 important plants used for pesticide preparations with corresponding common Nepali nomenclature. Some 40 other important medicinal plants that could be used for pesticide purpose were also given. Like other similar data from the third world countries, there was unfortunately no indication of any controlled trials and results which would given an idea of duplication and reliability.

In Bangladesh for instance an NGO, Proshika has been promoting ecological farming (EF) since 1978.[91] Trials on conventional farming (CF) vs. EF in respect of rice cultivation were carried out at 10 different locations in different regions for one year 1990-1991. In 5 of these yields in kg/ha were higher in 4 in case of CF, in one area it was about the same while in 5 cases EF yields were higher. These in all covered 1684 acres for EF and 604 acres of CF. All in all average yield in case of all the 10 regions, for EF stood at 2,263 kg/acre as against 2292 kg/acre for CF. On the basis of benefits vs disadvantages, EF emerged as the farming method of choice. Proshika has developed a non-chemical regimen consisting of organic inputs like dried potatoes and hyacinth leaves, resulting in high yields from chemical dependent HYV seeds of the rice.

In Malaysia where the ill-effects of pesticides on plantations amongst workers has been widely reported, it was only in

1991 that an organic farm was started. Three new farms have since come up in Sarawak, Malacca and Perk areas. However, results of farming from the economic angle are not available.

In Pakistan it appears that no sustainable effort has been made towards EF (ANGOC Manila report p.59).[91] Reference may, however, be made to the widespread use of a multipurpose Guar plant which grows in Punjab and Sind but has been introduced successfully in the North West Frontier Province. It is a good forage plant, a vegetable and soil ameliorator with Nitrogen fixing ability. It provides excellent ground cover. It is a hardy plant with no major disease or pest. Guar seed contains a mannogalactan gum which is of industrial importance with a world market.[92]

In Philippines a farmers organisation located in Bulacan has developed a balanced organic fertilizer called the Green Earth (Luntiang Daigdig) which when applied in rice increased farm income by 10 per cent. There was also an improvement in the milling recovery rate apart from improved soil quality.[91] A three ha. organic farm operated by IKAPATI Farms has come up for growing vegetables and other crops run on the biodynamic farming system. The yield is almost twice the national average and more than the now defunct Masagana 99 target referred to earlier. These trials have been widely welcomed by farmers and is finding followers elsewhere since inputs are down and outputs and returns much better especially for rice cultivation.[91] A mention deserves to be made here to the famous centuries old Bontoc rice terraces of northern Luzon at an altitude of over 1500m. Reports of 1981 indicate that average rice yields without use of any chemicals was 6.2 tons/ha. The national average of Philippines was 2.5 tons/ha. Intense successful use has been made of indigenous technology. For instance sunflowers and paswek plants were used to control a large worm (tuwing) that causes paddy seepage. Rats are prevented by keeping fields clean. There are a few other traditional practices of soil drying which help land management and release of the nutrients in the soil. Bontoc, is often cited as an excellent, classic example of an undisturbed traditional system which is highly productive and sustainable by any yardsticks. Integrated in the system is the socio-political structure of Bontoc and inputs of women. Yet there are plenty of unutilised avenues for improvement including use of crop rotation with legumes and improvements in nutrient cycling practices.[93]

In Philippines as elsewhere in Asia, rice-fish culture is highly productive in the same paddy. This increases rice yield from 20 to 47.5 per cent. Fish reduces weeds and insects, it enhances aeration which in turn helps extra tillering. This in the final analysis dispenses with the use of pesticides In the case of one successful rice-fish farmer, Mang Isko there was 50 per cent increase in rice yield plus harvesting of 48.5 Kg. fish. The case of another farmer, Bert Ignaco has also been cited who has developed 8 alternative technologies aimed at regeneration including the use of biofertiliser sources (Gliricidia sepium leaves and Azolla), swine production ,duck raising as also other livestock.[94]

In Thailand, a successful group is the Kaeyi group created by Khun Samrit Boonsuk since 1984, devoted to paddy and now named as Natural Agriculture Group (NAG). The group has produced in 1992 some 50 tons of rice from EF.[95]

In Thailand over 50 NGOs and several other organisations have been involved in sustainable agriculture but the rate of adoption by farmers is very small. However, there are a few traditional farmers all over the country. This situation is no different from that prevailing in India or elsewhere in the third world. An analysis of causes /constraints leading to this situation in the 3rd world will be discussed later since these have surprisingly a strong common denominators.

In N.E. Thailand, rice-fish culture has been expanding rapidly during the past 15 years. Maha Yoo, a successful farmer is credited to have played an important role in this area. Fish rice culture is now serving as the entry point for the start of integrated farm systems. This is leading to increase of vegetables, fruits and animals on the farm. Rice-fish farming is equally popular in Pakistan and India as in the Far East, including Indonesia and China. In fact in China there is evidence that fish in rice fields leads to a significant reduction of mosquito populations and incidence of malaria. There are several other fringe benefits in this system apart from increased employment and nutrition of the farmers. In several places, increased reliance is being placed on stocking with native fish varieties despite lower yields, on account of bigger demand-) for these varieties.[94]

Although time and again, in many situations and countries agro-forestry has created an important niche for itself specially in EF, for want of sufficient, authentic information, no reference has been made to this here. However, attention will be drawn to an outstanding example of Forest agriculture, a form of natural

farming as practiced by Vibul Khemchalern, a village head in Huey Hin Lad Krathing, Sanamchaikhet District in Thailand.

Facing many difficulties and losses in income suffered from chemical farming which forced him to sell off the bulk of his land, Vibul started growing herbs. He also grows crops for food and trees for fruits. For 12 years the farmer has turned the corner as the costs of inputs and labour have been slashed. This successful experience has given a new lease of life and dimension to forest agriculture in Thailand and helped them come out of their debts. Forest agriculture also helps protect biodiversity which has been threatened in Thailand as elsewhere.[96]

Agroforestry with a wide range of herbs and medicinal plants which are languishing and have either become threatened, endangered or extinct, offers a very interesting area of work. Take for instance the Moringa or Drumstick or Spinach tree in Africa. Such introduced or traditional species can be a boon to the consumers. Leaves of this tree in places like Zambia are widely used for relish. Unlike Leucaena, a fodder tree, termite attack does not seems to pose a problem. Propagation of the tree can be done easily through cuttings although seeds can also be used. Moringa has found a wide range of uses as a vegetable, as edible roots, pods nuts and seeds apart from as edible oils and fats. The seeds are also used as primary coagulant to purify water. Flowers are eaten and also used in Tea. Young leaves are used as vitamin C source and useful as livestock feed. Apart from its use as pulp wood, it serves as a good fence post or a fence if planted closely. It is an excellent quick growing fuelwood, a shade tree and helps soil conservation. In Africa it is also used against witchcraft and hyenas if you please.[97]

There are countless other indigenous methods applied for promoting agriculture especially in the old world—some of which have also migrated to the new world. For instance, in Andhra Pradesh the droppings of goats and/or sheep are mixed with equal amount of water and the slurry with soap powder swabbed on tree leaves to repel wandering stray animals from trees. Morning glory (Ipomoea cornea) is also grown round the tree trunk in order to provide low-cost protection. Anil Gupta at the Indian Institute of Management (IIM), Ahmedabad, for the past 5-6 years through their publication Honeybee has been collecting, collating and promoting indigenous methods and practices of farming, including pest control.[98]

These are no doubt pioneering and valuable efforts.

However, it would be imperative to establish through controlled trials, the veracity of these indigenous methods, which would help their adoption. Hopefully SRISTI set up at Ahmedabad for this purpose will undertake this formidable task. Honeybee has already reported on several of these *ad hoc* indigenous methods and practices not only from within India but also from Sri Lanka, Bangladesh, Bhutan, Honduras, Bolivia, Zimbabwe amongst other countries.[99]

In association with the IIM, Ahmedabad the traditional methods are being documented by various units including by SEVA, Madurai, Tamil Nadu by its' Chief, P. Vivekanandan. Winin Pereira in his excellent publication, *Tending the Earth*, (Earthcare Books, 1993) has also effectively and painstakingly brought out many of these indigenous traditional technologies and practices which were developed and obviously worked successfully over centuries in the country.[100] Once again to establish their veracity and effectiveness, which will also pave the way for any changes modifications and improvements, it would be of paramount importance that all such methods/ systems/knowledge are evaluated and their authenticity established beyond any reasonable doubt using modern tools of science and technology. As a matter of fact the problem is not one of authenticity alone but one of the habit of not recognising and accepting the observation and experience as adequate proof.

A wide range and variety of indigenous methods over the years have been on record from Sri Lanka and Africa amongst many other countries, including Latin America which are reported from time to time specially when there is a serious failure in the conventional agriculture set up. In Sri Lanka for instance biological methods of pest control have been mingled up with religious practices and rituals. These tend to maintain and develop habitats and micro-climates needed for the vertebrates, reptiles, birds as also mammals that destroy crop pests. For instance such practices encourage rat, snake and the lizard which in turn feed on a number of small mammalian and crustacean pests of paddy.

Several plants have been used for pest control. These include kaluwel, tithawel, pineapple which control various honey-bee flies. The leaves and seeds of some of these plants are crushed and introduced in impounded water for paddy irrigation. Seeds of Kital, Karadha and Keppitiya are likewise added to paddy soil for the control of rice pests. Some plants like Madu are hung

around paddy fields possibly on account of anti-pest odorous emitted.

Interestingly, raw papaya pieces are added in paddies as enzyme papain found in abundance in papaya fruit, causes damage to rats. Wood ash has been used the world over but certain plants like Cymbopogon sp. are considered particularly effective in controlling Spodoptera sp. Amongst the mechanical methods, food and oil lamp traps have been widely employed in Sri Lanka. This concept for instance has been extended to India and white electric light bulbs are being widely used. [81,82,83]

In Bhutan also a variety of practices have been used / developed such as the use of pungent smelling mushroom, Silla, as an effective deworming agent in humans and animals. The roots of Shutara weed are used for flea and lice control while the roots of Panpey plant are used for the control of stored clothes. A number of such practices, some of these needing verification have been recorded in Faridabad District of Uttar Pradesh as also in Gujurat. These range from the control of insect pests of sorghum with Aag Futla in fruits, white grub in fruit trees, fruit fly in mango, caterpillars in Castor and rats in granary using cumin plants.

Pereira, amongst many indigenous examples refers to the use of a mixture of buffalo dung and asafetida (hinge) in water for smearing of brinjal roots. If grubs appeared, the methodologies were changed and in addition garlic, camphor, sulphur were also used. Leaf insects were controlled through sprinkling plants with cows' urine.[100] Likewise white ants in sugarcane crops in the field were controlled by use of cowdung mixed with salt and copper sulphate. This seemed to kill the fungi on which white ants depend for their food. The storage of paddy was done in Bengal in especially devised *mora* made of loose straw and tied hard. Inside, these were plastered with earth and cowdung. In the Bombay area on the other hand neem and karanj leaves were put over paddy in a 50-75 kg. capacity large clay pots and neck plastered with cowdung plaster. In stored paddy, wood ashes of babul, casurina, mango and tamarind were used traditionally. Powdered or whole dried chilies are also used as also water hyacinth to kill rice moth.

In Bengal, 2 per cent powdered and rhizome of turmeric is mixed with rice for storage. Fresh or dried leaves of supta were also used for paddy as also leaves and flowers of komal apart

from Nirgundi leaves. As per reports, in Tamil Nadu some rice varieties could be stored for several years—possibly these served as an insurance during draught and famines. Apart from pest control in rice and for the protection of stored sorghum and pulses, a large number of plants were used effectively. These included lime leaves, soapnut, vach, adulsa, groundnut and neem amongst others. Grains were also coated with oils, ash or sand and these practices varied from location to location.

Methi(fenugreek) leaves and *mastaru* (wormwood), turmeric powder, mustard oil and common salt were also used for rice Ground black pepper, garlic oil, custard-apple seed oil and a wide range of several other plant products were used for grain storage.

Use of Emetic nut (madana) for protecting grains was common in the Konkan region. Castor, groundnut, coconut, rapeseed and other oils were also commonly used as preservatives for foodgrains and pulses. While in Mysore, use was made of wood ash mixed with beans, in Punjab it was cow dung ash mixed with cereals kept as seeds. Wood ash from tamarind, babul, suru, mango and tamarind was used for pulse while in Sri Lanka, farmers burn neem leaves for storage of pulses.

Layers of leaves of sava, finger millet, supti and citrus species as also castor oil found use for pulse protection in storage. Yet another interesting source of pest remedy is a compound isolated from water hyacinth, a common water weed. This kills the common rice moth *Corcyra* sp. a common storage pest of cereals and oilseeds.

An area where indigenous plant pesticides have achieved success over centuries is weed control according to Pereira. For instance niger (khorasni) grown for seed or as rotational crop or ploughed as a green manure has been found to serve as a weed control. Similarly the sann plant was grown to control weeds since it is known for fast growth. This was used successfully for control of Lowala weed.

In some cases such as Jawasa, a leguminous weed, control was attained through flooding of the field. Neem, the omnipresent and omniuseful plant was grown by farmers around fields in order to kill off the weeds. The age old method of change of crops after 2-3 years seemed to work for instance in getting rid of nutgrass weed . Likewise a symbiotic selection, growth and choice of crops such as mothbeans and pearl millet sown together, keeps weeds down. For control of root-parasite or

the witch weed, trap crops like cowpea, castor etc., have proved successful. A number of oils from plants including from the tobacco seed applied at the roots have been reported to be successful in control of Broomrape weed. Unlike the present day practice of wholesale rejection and elimination of weeds, in traditional systems weeds have been conserved and used as food, manure, fuel and other agriculture based uses such as for erosion control. This apart weeds have also been used for thatch, packing and as a source of chemicals apart from as fuel and paper and this covers weeds which are considered to be highly troublesome in agriculture.

Of interest is the wide-spread use of weeds in the control of ailments—such as motha tubers for water purification, fever, diarrhea and stomach disorders. These tubers are also considered to be anti-inflammatory, analgesic and anti-pyretic. Many of these uses have been developed by tribal people over the decades if not over centuries, through trial and error. While the future no doubt appears rosy, the switch over will have to be handled delicately and with care.

The traditional techniques used in Southern Mali in the Sudan zone involve use of cribs, granaries, silos, jars and gourds. Plant extracts of green leaves root bark powder and crushed plant mass are commonly used. Exposure to smoke is also resorted to as also to the use of neem. In Senegal also oil coating is used as a method for grain preservation. Similarly there is widespread use of indigenous plants to protect harvested crops as also the seeds, including cotton seeds.[101] The root bark of Prospos Africans for instance is reputed to protect grain for 3-5 years. A number of similar plant products have been mentioned in the above write-up by Siake Kone. Some of the plant products are rated to give safe storage upto 7 years both for grains and seeds.

A US company in Boston, MA have recently reported the development of a grain storage facility—a flexible PVC envelope which is reported to store grain without use of fumigants, insecticides. The storage is particularly safe from Rodents and eliminates total use of pesticides.[102]

Botanical Pesticides

Reference has been made to use of different parts of indigenous plants quite often after extraction, as pest control agents. Most of these practices were no doubt based on experience and a good example of this is the Neem and Chrysanthemum amongst

many others. The wisdom and experience of our farmers is quite evident when we find that present day scientists have in fact, based on these usages and observations, isolated and identified a wide variety of active chemical pesticides compounds from these plants. A number of groups/scientists have devoted considerable time and attention to this area leading to several important compilations and treatises on the subject.

In a survey of literature done in 1989, Narinder Kaur and Dudani had brought out a list of 19 medicinal plants with reported insecticidal activity. These plants were taken from authentic official publications which should give these some credence especially since the details of parts of the plant as also the pest against which these were active and the method of extraction were also available.[103] Likewise Grainge and Ahmed had compiled a list of 41 pest control plant species which reportedly possessed broad spectrum pest control properties.[104] In an earlier study Ahmed and Grainge had brought out not only the pharmacological uses but also toxicological and other limitations of this economically versatile tree.[105]

An excellent compilation, Botanical Pesticides has been brought out (1990) by Y .V. Suryanarayana.[106] This Souvenir has been compiled in a tabular form and gives the name of the insect and/or the crop affected, the active plant part with a corresponding reference. Bibliography has been divided for insect pests, root knot nematodes, tobacco mosaic virus, fungal and bacterial diseases. Yet 2 other outstanding publications with a wealth of knowledge have appeared in 1993 one authored by M.S. Chari and Ramaprasad and the second by B.S.Parmar and C. Devakumar. These are in addition some excellent publications devoted exclusively to Neem including the IARI Neem Newsletter.[107,108,109]

While this rich information is available so readily indicating the wide range of effort that has gone in the academic studies over the decades, it is only recently that commercial preparations of neem and a few other common indigenous plants like garlic and some other products under the label Herbal have appeared on the market. In fact patents have been taken out on Neem in USA and elsewhere. There are reports that the patent on Neem has been challenged by the NGOs in the USA. It may be recalled that a US patent on transgenic cotton was revoked by the Indian Govt. as also in USA after these attracted considerable criticism around the world. It seems quite clear, however, that effective use has not been made of the extensive indigenous and

traditional knowledge and experience of botanicals in the area of pest control as has been achieved by manufacturers of chemical pesticides.

Reference may also be invited here to the excellent and rich information on indigenous botanicals collected and collated by Pereira some details of which have been presented earlier.[100] As per Pereira's estimate some 500 medicinal plants have be in regular use over the centuries. An important point to remember is that all in all it was a package of practices, including intercropping rotations, physical and biological methods and practices including fallows and the use of specific combinations of plants that achieved the desired objective of pest control. Timing was another important factor.

With this clear wealth of knowledge and plants available, it is time that practical, field oriented studies are undertaken before it is too late. Considering that there are authentic and disturbing reports of many of our plants having become extinct or endangered on account of callous disregard including over-utilisation and exports, it is time that careful and speedy attention be paid to this neglected field.

Organic farming with a strong reliance on use of plant products, biological pest control, vermiculture and other cultural practices including use of pest resistant seeds has been attracting increased attention as is apparent from the Proceedings of the Seminar on Organic Farming at Kottayam, Kerala.[111] Some of these have been covered earlier. A gist of some others is given below to show the directions of our interests. C. Dharamrajan and his co-workers from the Tamil Nadu Agricultural University (TNAU) Coimbatore for instance presented results of successful trials using vermicompost and botanicals in raising tomato seedlings and soybeans. N.Raja and K. Vijaylakshmi of the Centre for Indian Knowledge Systems, Madras, highlighted the use of indigenous plant products as promising, potential bio-pesticides. Use of a variety of microorganisms both as biofertilisers and biopesticides was brought out by D. Purshothaman also of TNAU.

The benefits of organic farming coconuts was drawn attention to, N.P. George from Maharajas' College, Ernakulam, Kerala, who advocates multistoried agroforestry. G.K. Veeresh and coworker from the University of Agricultural Sciences, Bangalore spotlighted the relevance of organic farming while C. Jeykaran gave details of commercial operations of his organic

farms located at Kurinji in the Palani Hills of Tamil Nadu. A team from the Indian Institute of Spices Research, Calicut presented their data on eco-friendly disease management strategies (Y.R. Sharma and co-workers). Production of cardamom, using organic system was brought out by S .N. Potty and co-workers based at the Indian Cardamom Research Institute, Myladumra, Kerala. Two papers were presented on use of organic system for coffee production one by Y. Raghuramula and R. Naidu and another by M.Balakrishnan and co-workers, both from Central Coffee Research Institute, Chikmagalur, Karnataka.

A recent report gives the experiences and thinking of a successful Karnataka farmer who was practicing chemical farming from 1972-87 with the introduction of hybrid seed varieties and other inputs of the Green revolution. However, like several other farmers the acute problems associated with this farming system caught up adversely with this farmer also resulting in fall in production and returns thus leading to his reverting to the organic farming . This, says the farmer has improved his returns and yields apart from his regaining his health.[112]

In another report from Cambodia experience of farmers feeding fish ecologically and the returns to farmers through fish have been highlighted claiming modest success at the Great Lake which provides nearly 60 per cent of the country's fresh water fish estimated at about 70,000 tons annually.[113] M. R. Bhiday (late) discusses organic agriculture and considers it a rather successful holistic approach to meet the country's needs from various angles including sparing of scarce fossil fuels.[114] Citing the experience with use of neem products for cotton cultivation, the writer considers this system to be the most suited for small and marginal farmers which also supports the mixed farming pattern in common use in the country.

The pioneering work in India on the neem has already been brought out above which was documented by the IARI in its research bulletin No.40 in 1983 and updated in 1993 covering work carried out since 1950, possibly to coincide with the 4th International Neem Conference held in India in February 1993.[115] On this occasion another comprehensive publication was also brought out by Randhawa and Parmar. [116] Mention must also be made to the pioneering efforts of Ketkar who was involved in promoting the virtues of Neem [117], there was world wide attention on Neem specially the pioneering efforts undertaken in Germany which led to the first two International Conferenc-

es being organised in Germany in 1980 and 1983 followed by a third conference in Nairobi in 1986 and the fourth one in India as mentioned earlier. The work in Germany since early seventies was carried out with devotion and depth with eminent scientists like H. Schumetterer and coworkers including Ascher K.R.S., H. Rembold and Veronica Utz at the University of Giessen, in Germany. It was in fact this group which was responsible for organising the Seminars and bringing out various publications through GATE, a GTZ Project located at Eschborn in Germany.[118]

Mention also must be made to the yet another pioneer M. Jacobson in USA who has brought out several reports on the value of Neem since 1958.[119,120,121] More recently, there has been intense interest in the African continent in the use of not only Neem, but also other plant products specially in Nigeria which has been ably reviewed by L E N Jackai.[122] The Neem movement received further support from the Symposium organised at Rajahmundry in 1990 with special emphasis on IPM.[107]

This carries papers from leaders in the area of botanical pesticides including some earlier workers and promoters like C.M. Ketkar and R P Singh. There has also been considerable renewed interest on the subject in Pakistan as evidenced by aecent write-up by M.H. Panhwar and Farzana Panhwar.[123]

Of late some of the NGOs such as Neem Foundation, Bombay, Society of Forest and Environmental Managers Dehradun, DS Manav Vikas Foundation, Pune and Centre for Indian Knowledge Systems, and Prepare Madras have been involved in this area.[124-127]

This recent and earlier pioneering work and interest and R&D thrust not only in Neem but several other plant products like garlic augurs well for the growth of organic farming in the country specially in the light of a strong interest and bias in favour of tea, coffee and cotton world wide and the high returns that these bring to the farmers not to forget the health and the happiness of the consumers and the environment. These successful efforts are also reflected in the number of patents taken world-wide for Neem products, which are now beginning to be freely available in the market notwithstanding several controversies surrounding these on the patent rights and related issues of intellectual property rights—matters of utmost concern to the third world countries.

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Chapter - 12
Earthworms

We have discussed various systems, methods and tools that have been evolved, developed and successfully used by man in his efforts to produce a range of foods and fibres over millennia.

This has covered physical methods, biological methods and the use of botanicals mostly in combination. In addition there have been attempts to identify and develop species and varieties which may be able to resist partly or fully pest attack, while keeping in mind the yield and productivity. Some of these factors of course are more of recent origin and have arisen due to dwindling land area and higher needs and demands partly on account of increased population.

A group of invertebrates, which live in soil and popularly called earthworms make a substantial contribution to the soils. Their feeding and burrowing habits and activities create organic residues and amendments thereby helping decomposition, humus formation, nutrient cycling and creation of a suitable soil structure and environment for the growth of plants and other beneficial organisms.[1, 2]

Earthworms have obviously existed for millions of years and have been ploughing the soils and fertilizing them and contributing both physically and chemically. Earthworms have thus been used as biological indicators of soil health and fertility and are generally accompanied by supporting populations of other essential organisms, including fungi, bacteria, actinomycetes, protozoa, insects, spiders, millipedes to name some.[3]

Without identifying the species of earthworm, in 1881 Charles Darwin had recognised their special role in converting dead plant and animal litter in soil as also their important function in soil aeration, structure and fertility. It was by C.A. Edward's and J.R.Lofty beginning 1971 that some basic studies

were conducted on earthworms. According to Sultan[4] there are some 1800 earthworm species around the world - although Bhawalkar has placed this figure at 3000.[5]

Earthworm species have been placed in 3 morpho-ecological groupings–Epigeic species which stay on the surface are consequently more exposed to climatic fluctuations and the pressures of predators. These ingest large amounts of decomposed litter and are phytophagous. These tend to be small with rapid generation times and are commonly known as redworms or manureworms. A common example is *Eisenia foetida* and is used in vermicomposting.

The second group, endogeic, are subsurface but do not burrow too deeply into soil and mostly build. *Lampito mauriti* and *Octohaetona serrata* are two common examples.

The third group comprise the deep burrowing ones and can go down upto 3 metres – a common example is *Pheretima elongata*.

New Zealand scientists were credited to be possibly the pioneers in the use of earthworm on a large–scale in agriculture and possibly the first commercial biodegradable facility of about 10 tons/day was set up in Canada. Today there are a large number of such commercial set ups in USA, Japan, UK and many other countries some of these handling over 200 tons/day in USA. [6]

In India, while a number of institutions/individuals have been involved in this area, New College, Madras (Sultan Ahmed Ismail), Inora, Pune setup by late Prof. M.R. Bhiday, now run by R T Joshi and Ms. Vaishali Tamhankar and Bhawalkar Earthworm Research Institute(BERI), Pune, come to mind. The R&D and extension work of Sultan like that of Inora is on an institutional basis, while the operations of BERI are on a commercial level. In fact apart from their undertaking training work in USA, BERI seems to be working towards the possibility of exports of earthworm castings which are fetching Rs.4000 per ton in India against Rs.50,000/- per ton overseas.[7]

BERI has developed technology centering around *Pheretima elongata* whereas Sultan advocates *Lampito mauritis* and *Octochaetane serrata*. Inora is recommending *Eisenia foetida*, *Perionyx excavatus* and *Eudrilus euginae* species. These species are amongst the many identified as suitable for use for

vermicomposting in India. BERI does not approve of the use of Epigeic group of earthworms (redworms or manure worms) and relies on deep burrowing species—*Pheritima elongata*. BERI also questions the desirability of referring to redworms / manureworms as earthworms—unlike Sultan, Vaishali and Mathew Werner of UC, *Santa Cruz*, USA.[8] To add spice to the controversy Ann Lindsay says,"redworms, not earthworms or night crawlers are best suited to the vermicomposing system." [9]

Prof.(late) Bhiday before starting *Inora* had been experimenting on earthworms for 10 solid years while serving at the Pune University and established Inora on a grant from the Department of Science and Technology in 1994. The idea was to establish an R&D centre for providing technical back up for the 20 wormicomposting centres in different states in the country. Eight such centres were set up at the Military Dairy Farms in the Southern Command with a capacity of 10 tons per day. An important part of Inoras' work has been providing training for farmers groups. Inora has had a hand in the setting up of the experimental wormicompost unit for the Delhi Development Authority on the outskirts of Delhi near Gurgaon. Unfortunately like many other DDA projects this one has also not survived. Inora has been providing consultancy services for organic farming, wasteland development, mushroom cultivation and organic pest control which seem to be all closely tied up and interlinked activities. Vaishali of Inora worked in USA during 1994-95 with the Community Gardening Programme in the city of San Jose, California and helped establish several units for family gardens and schools. From the write up on her activities in the Worm Digest and glowing references to her work, it seems that her work has been most rewarding. [10,11]

The studies at Inora have established that vermicompost contains earthworms' cocoons, beneficial organisms, including actinomycetes, enzymes and hormones apart from NPK in adequate amounts, all in readily available form. Earthworms have also been found to trigger biological activity in soils and make it loamy in addition to improving soil pH. These worms increase soil drainage as also water retention capacity of soils. This apart there is positive improvement in soil health leading to reduced pest attacks leading to improved soil productivity. Finally by all accounts the farm produce seems to gain better lustre, taste and keeping quality apart from freedom from toxic, undesirable chemical residues, a cause for serious concern

specially in children.

There is thus no doubt and a total unanimity on the many qualities and attributes of earthworms which are known to play a key role by serving as bioreactors and supporting beneficial soil microflora and protecting these and acting as effective biocides. They grind the rocky soil to a neutral pH in an available form. The soil particles are held together through ion-exchange and made available to the roots and also preventing their leading to groundwater.

Studies in the US have shown that earthworms can help double the yield of wheat, improve yields of grass by 4 times and yields of clover and herbal plants by over 10 times. The wide range of micro-organisms harboured by earthworms make available many essential micronutrients, vitamins, antibacterial and plant growth hormones.

Earthworms literally churn the soil and thus help bring up minerals and other nutrients to the root systems. This also significantly helped absorption of water. These worms have a muscular gizzard enabling them to grind food to 2-4 microns, making it readily available by providing a large surface area for cationic exchange enabling more area for retaining the nutrients.[12]

In vermiculture or vermicomposting organic wastes such as sugarcane trash, stems of bananas, paddy and other straws, all manner of weeds as also food wastes are fed to the earthworms under three different types of earthworm systems referred to earlier. It has been established that unlike chemical farming, expenditure on tillage is reduced as also the need for chemical fertilizers.

Expenditure on weeding is brought to almost nil and there is hardly any need for foliar sprays. The same is true for water requirements which are reduced by 80-90 per cent, Bhawalkar claims for instance that whereas pomegranate under chemical farming costs about Rs.110 per plant, using vermiculture the costs are reduced to Rs.30 per plant per year during the 2nd year. For grapes also cost of inputs with vermiculture was reduced by 60 per cent, apart from the nearly 50 per cent higher production. Residues of food processing units is also used as a raw material..

For sugarcane and vegetables there were similar trends or better. Vermicomposting has emerged as much sought after

input. For instance these fetch Rs.50,000 tons overseas and around Rs.4,000 ton in India indicating both scope and zest for exports.

One of the strongest selling points of organic produce would be improved nutritional quality and improved taste pointed as has been brought out. [13] Although sufficient data does not exist to warrant any hard conclusions of superiority of organic foods over the non-organics, the above report establishes significant nutritional advantages. The results of this 2 year study, involving analysis of 30 samples of each of the farm produce showed for instance superiority of apples and tomatoes in respect of vitamin C and A contents. Organic potatoes also showed superior mineral content in line with earlier Swedish studies which had reported decreased nitrate level and increased vitamin C in organic potatoes. These studies had also shown higher survival rates and fertility among animals raised on organic feed and hens on organic feeds yielded larger yolks and less albumin.[13]

Mention deserves to be made here of the excellent work of Hauser in Cameroon which indicates that the earthworm activity was increased by permanent shading in the vicinity of the hedgegrows.[14] On the other hand casting by earthworms was also seen to improve soil nutrient status considerably in terms of several essential nutrients. Prabha Kumari has shown the important benefit of earthworm since there are no foul smells created in the process of composting. [15] The work of Haridas of the Tata Tea Centre, Munnar shows how tea waste can be usefully utilised using vermiculture systems.[16] The importance of the earthworm can be gauged from the special issue of the International Ag-Sieve which carries a special piece on commercial benefits reached by Cuba from use of vermicomposting in its switch over to organic farming as a sheer necessity which has been converted into a blessing.[17] Apart from carrying highly interesting and useful information on field experience with vermicomposting in USA and Australia, the above Special issue also carries a detailed account of the success achieved at the Maharashtra Agricultural Bioteks, Pune, which has been at it for over past 10 years with the support of the Department of Science and Technology, Government of India in its drive to expose farmers to the benefits through training, education and demonstration. The project is operating in 13 States in the country led by Hemangee

Jambekhar.

A recent report strongly supports worm composting specially for use in city farming, including its use for recycling, garbage disposal and as a means for social and environmental development [18]. A strong case has likewise been made for an integrated approach to organic farming and a suggestion has been made for setting up Organic Demonstration Farms in UK by Joy Greenall a concept that was widely used for spreading the Green revolution in India with great success.[19] Another report on the progress of organic farming in Holland advocates 'Reward for Results' as policy tools and draws satisfaction from the fact that in Holland in 1995 the pesticide use has in fact fallen by 2.2 per cent.[20] Yet another welcome report comes from Welsh Institute of Rural Studies at the University of Wales which indicates rapid expansion of organic farming and acreage from 0.12 million ha in 1986 to over 1.3 million ha. in 1996, an increase of some 25 per cent annually. The number of farmers has also correspondingly gone up from 7800 to over 55,000. [21] Lastly Christopher Williams [22] gives details of a new system developed which he calls free range composting and is derived from the experience gained at Pune.

It, however, seems that despite all the effort, considering the unlimited benefits waiting to be harnessed both in vermicomposting and in the process of helping disposal of city wastes, the savings in energy and production of organic foods via city farming and otherwise and safeguarding health, it is high time that a national effort is funnelled in this direction.

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Chapter - 13
City Farming

City Farming – specially for vegetables and some fruits has been a very common phenomenon in towns as well as many cities around the world including India. For instance the writer can recall Bangalore raising its' sizable supply of vegetables from within 5-10 km of the town/city centre in the fifties. Same has been the case with Delhi, Ludhiana, Ranchi, Karnal and Panipat for instance until about 3 decades ago and whereas the populations to be fed have grown the land sizes in most instances have seriously dwindled.

New Delhi until about 15 years back got its supplies from present day housing colonies located 10-15 km. from the down town both in South Delhi and East Delhi across the Yamuna River. The same was the case with north and western areas of Delhi. In fact the river embankments in Delhi as elsewhere in the country continue to be a rich and easy source of supply of vegetables when the river waters recede during colder climates. However, population pressure in the Third World has been resulting in decrease or near closing down of this activity specially due to entry of industry and the high cost of land.

The benefits of city farming are too evident to need any reiteration and the world over there is now realisation once again in favor of the value of city or urban farming. This really means we are back to the Incaic, Aztec and Mayan cities, or early Javanese and the Indus valley settlements and the Tigris and Euphrates era.

In some of the countries in Asia, there has been stress given to city farming by the planners, although this cannot be said in respect of India where there is a total absence of any policy direction on the subject. In fact even the

limited application of such a policy on surplus frozen urban lands or green belts in the cities (or utilisation of areas along rail tracks) has not found any application, implementation or support.

As pointed out in the International Development Research Centre's (IDRC) Reports, urban agriculture remains unacknowledged or prohibited even during times of acute food shortages, although it is clear that with a little planning the cities could well utilise and recycle surplus waste water.[1] Further with the advent of vermicompost farming, not only can organic and food wastes could be well utilised along with waste water but in the process this could serve to provide nutrition at low cost to the needy and generate employment. Further this could serve as a good energy saver by less reliance on transportation. Nevertheless it is estimated that about 200 millions are engaged in urban farming globally providing food and income to some 700 millions. For instance in many of the African/Asian cities, animals are raised within households. The figures for vegetable productions vary from city to city from 25-85 per cent in cities like Karachi, Shanghai. Cities like Honkong, Kampala and Singapore produce 70-100 per cent of the poultry they consume. Poultry production as also vegetable production is also high in the immediate neighborhoods of cities like Delhi, Calcutta, Mumbai and Chennai in India but the potential is still higher.

Adequate supply of food at affordable prices, or better still if it is self- produced helps adequate intake and in turn helps nutrition and health, including improved capacity for work. Urban gardening as per some surveys cover a large variety of farming systems which includes aquaculture, horticulture, livestock, agroforestry, silkworms and medicinal and culinary herbs. Considering the high value of land in urban areas, this no doubt requires efficient technologies and knowledge and adoption of small –scale operations. These may include the use of hydroponics and in case of animals, recourse to stall feeding. In case of poultry this has taken the shape of multistoreyed cages, unfortunately also creating its own problems. City farming offers a specially splendid outlet for women's' employment and income generation.

With proper planning and management, the use of high quality and high priced city drinking water for city gardens can be avoided by the use of sewage treated water or better

still the use of unfiltered river or tubewell water as for instance was the case in Delhi. If urban agriculture could be organised totally on the systems of ecological farming, this would add further to its' utility as the danger of pollution of water from agrochemicals would be avoided. Organic farming has, as we have seen, proved to be completely reliable and dependable even on larger rural farms, and there is no reason why this could not be used in the urban areas. This would also give a fillip to utilisation of organic wastes through use of vermicompost method. Incidentally, as has been shown time and again that unlike compost making, there is no foul smell during this process. According to Prabha Devi, this is because the earthworms emit sufficient oxygen to oxidise compound like hydrogen sulphide (H_2S), mercaptans, skatol etc. from the decaying wastes, converting these unpleasant smells into odourless end products .[2]

In China extensive use has been made of recycled human wastes from households for urban agriculture. Urban farming has become very common in Mali, Senegal, Dakar and in Togo. Zaire and Nigeria have officially come out in favor of urban farming. While Zaire is subsidising access to water and drainage, Nigeria has made all inputs like fertilizers and seeds, tax free.

As in West African cities, in Kampala, Uganda also there is a considerable interest in city farming. There are similar encouraging reports from Addis Ababa in Ethiopia. Experience with recurrent famine, drought and war had convinced the urban dwellers of the utility of city farming which had been on the decline. Despite lack of support from the Government some of the home gardens had been in existence for as long as 45 years. Home gardening is generally being carried out by larger, extended families which allows sharing of work and ensures co-operation. These collectives had more money and were generally better off in the process. Most of these are along canals and practice intensive farming. Such cooperatives are also protected from exploitation. It was also noted that some 60 per cent of the families engaged in urban agriculture owned their own homes and the extra income helped them to go in for higher education.

A survey of the potential of urban agriculture in Dar-Es-Salaam, Tanzania showed a similar picture. In fact the urban

farmers there are receiving technical advice from the agriculture extension staff throughout the city, leading to successful farming results. A study in Kenyan cities also shows that the urban poor will starve but for urban agriculture. In fact it is now well recognised that urban agriculture is possibly the most efficient and cost effective tool for transforming urban wastes into food, reduce poverty, provide better nutrition and environments and conserve energy and other natural resources. A 1985 survey had estimated value of crops of one season in urban areas in Kenya at about US $4 million. Unfortunately even such an important prospect has not weighed with Government authorities to encourage and evolve urban farming systematically. Some 29 per cent of urban families grow their own food whereas 17 per cent in urban areas keep livestock (chickens and rabbits being most common) as against 51 per cent of families in the entire country.

The survey showed that 1.4 million head of livestock valued at US $ 17 million was kept in urban Kenya. Thus urban farming has emerged as an important employment alternative in many urban areas.

In Harare, Zimbabwe, it is reported that the plots around public tenant flats are cultivated extensively. Even some wives of senior civil servants run these gardens. For instance on one of these the owner grows regale - a drought resistant leafy perennial known for its rich minerals and vitamins in addition to corn and pumpkin using dish water and domestic garbage. However, thefts are common on such fenceless unprotected city plots. Obviously home gardening is a world-wide phenomenon with varying degrees of application to support different felt-needs as we have seen.

In Bolivia for instance, in the high Andes many of the indigenous Indians are faced with hunger in this land-locked country and dependent on food aid. Consequently there has been a decline in food crisis since 1958. And urban farming is coming to their aid. This is most welcome specially following cholera epidemic which has increased demand on home garden products. In Mexico also the home gardens are serving people to rebuild part of their former environments after moving to a new place.[3-8]

Soleri and Cleveland consider these activities all over the world as a tribute to man's ability to adapt and to survive changes. Many of these changes are spontaneous in respect of

rural folks moving to urban areas in order to maintain their traditions, nutrition and health as also to generate some income. These writers refer to similar activity in low-income ethnic households in Tuscon, Ariz. USA who have taken to unique crop varieties including distinctive traditional foods brought from back "home". These may cover medicines, flowers, condiments amongst other items.[9]

City gardens have proved a boon for rural to urban migrants all over as also to mere squatters' settlements for instance in Mexico. For Afghan refugees in camps in northern Pakistan for instance, such gardens were the first to be embarked upon. In many cases this has led to the utilisation or reclamation of boggy lands or saline lands or otherwise waste-lands. With a little planning and encouragement these gardens could subserve as nutrition gardens for the family, the community or the township. For instance encouraging growing of Amaranth, which has 277 retinol equivalents of vitamin A/100 g., is a far better choice than cabbage with only 9 retinol equivalents vitamin A per 100g. cooked. There is also a tendency to forego indigenous fruits and vegetables perhaps in an attempt to find new identities, even though such foods are invariably nutritionally superior.

While most of the house gardens have been centred in areas of high population, in some cases such as in Santa Rosa in a village in the Peruvian Amazon with very low population densities (1.4 persons/ square km) each one of the 46 households had a home garden. These also had a remarkable diversity. The 21 gardens studied showed a total of 168 species, possibly one of the highest plant diversity. Each of the gardens had 18-74 species.[10] This wide biodiversity is comparable to the one found in Java with 179 species. These gardens contained guava trees— the most common species, oranges, coconut and banana. Sacha culantro and umari were other species. There were wide varieties ranging from medicinal plants grown by a traditional healer to timber trees.

David Caeser in a report of a field visit to Southern Mexico to study home gardens in the Yucatan Peninsula throws interesting light on how these have been functioning possibly for the past 2000 years. First of all there are no off-the farm inputs. The planting is done quite often by a vertical and horizontal distribution of plants to catch the maximum

sunlight. The home garden initially has annual crops such as corn, beans etc. followed by perennial species such as coconuts, citrus, mango, trees which need anything upto 6-8 years to yield results.[11] The gardens look after economic needs, including firewood and construction timber apart from medicinal plants, spices, herbs, animal forage and pesticidal plants. In one home garden, 117 individual plants representing 52 different species were identified, 47 per cent of the plants were for food production and 35 per cent of ornamental value.

Angela Brener-Suarez studied the use and propagation of medicinal plants in Mayan home gardens in Southern Mexico. The study was basically aimed at identification and propagation of wild medicinal species with a view to explore their domestication process. These studies have been undertaken under the leadership of Steve Gleisman, the dynamic Program Director at the University of California, Santa Cruz (UCSC)[12]

In Indonesia, homelots are being given to promote food security amongst transmigration who have been relocated over a century from densely populated areas of Java, Bali, Madura and Lombok to new settlements on sparsely inhabited outer islands of Sumatra, Sulavesi, Kalimantan and Irian Jaya. Although these have not proved highly successful, nevertheless they hold promise for the future.[13]

A struggling home garden scheme on a poor soil in Dasmarines started in 1986, located some 28 Km. South of metro-Manila has now turned out to be rather successful and thriving. This change really came with the installation of 7 deep tubewells in August 1993 with a grant from a German agency. They have also started in mid 1992 a Bio-intensive Gardening Association (BIGA) which is now marketing organic vegetables in Manila at twice the normal price, so great is the demand. BIGA has turned the corner since the water pumps installed enable them to have vegetables around the year.[14]

Incidentally Asian Vegetable Research and Development Centre (AVRDC) based in Tinan, Taiwan has been taking a leading role in promoting, through training, R&D home gardening in several countries. A good deal of AVRDCs work is being conducted in Bangladesh although it has also entered the Philippines.[15,16]

It is not only the older Third World countries which have

been practicing urban agriculture but also the industrialised nations. For instance USA has been promoting city gardening for the homeless in collaboration with the Homeless Centres in New York city and Washington, DC with support from Rodale Institute. The program is in its beginnings but is rated to have high potential for expansion and success.[17] In Knoxville, Tennessee, political scientist Kenneth A. Dahlberg and others have created a Food Policy Council to make cities more self reliant in food. The council believes that the city ought to have a Food Department considering that produce from US gardens (urban and rural) is about 18 US $ billions a year - about the same as that of a corn crop each year.[18]

At the UCSC, the old French methods rooted in the 16th century with plenty of horse manure have been revived and the results are rather impressive. Using a variety of crop combinations, with one crop providing shade for the other, UCSC have brought out a remarkable change in out-of- season vegetable production like spinach and lettuce[19] There are other beneficial combinations like carrots and leeks. Another need is that of a good supply of organic fertiliser.[20]

Cities in UK, including London, under heavy bombardment during World War II and at the end of the war made a tremendous success of home gardening to keep their nutrition and spirits and morale soaring .Such is the intense world-wide interest in urban agriculture that senior professionals from Canada, Chile, France, Germany, Netherlands, Sweden, Switzerland, UK and USA got together in a Workshop in London on 29th June 1994 on the subject. Organised by the Urban Agriculture Network, it was co-hosted by Natural Resources Institute and Development Planning Unit of the UK An impressive promotional program has been planned by the Urban Agriculture Network located at Washington DC to promote urban agriculture globally.[21,22,23]

NGOs such as Oxfam, CARE, Save the Children apart from UNICEF, GTZ amongst others have been in the forefront of supporting urban Agriculture with mainly nutrition of the weak and deprived in mind, in addition to creating employment, yet another side of the same coin. These NGOs have been active in many parts of the world, notably in Africa and in addition IPM has also received sizable support from them again primarily in the African Continent. [24] UNICEF for instance under its' Pacific Programme have surveyed Honiara

through the Solomon Island Government. The results of the survey show that nearly 20 per cent of the households in Honiara had started growing food, a step which is bound to improve the nutritional status of the child, an area of concern world-wide.[25]

In Argentina also rural gardening is catching up. As per a study, urban families are saving as much as 25 per cent of their food expenditures in this way. This apart they are including new exotic vegetables in their diets also. These studies cover Copacabana and Cordoba cities of Argentina.[26]

A mention will be made here to the comparatively simple system of hydroponics, or growing plants without soil- a space saving promising system applicable the world over. The word hydroponic word has Greek origins and actually means growing plants in a liquid rather than soil. Small units are placed on window ledges. The supply of water and mineral nutrients normally does not favor disease and insects.

Commercial hydroponics need an energy source to pump air and recycle solutions. However, the AVRDC System developed in Taiwan needs no external energy source and is thus more viable even in rural areas in developing countries. In Latin America what is now called the Peoples' Hydroponics (HP) has been developed with the support of FAO and the NGOs. This has also meant more employment and work for women.[27,28]

Both Helen Keller International and CARE working on promoting home gardens in Bangladesh have concluded the multifaceted advantages of home gardening specially the improving nutritional status and health of the poor.[29]

What is true of city farming for vegetables also holds good for landless livestock keepers and literature is replete with many such success stories. In fact this is now a world wide phenomenon arising from the concept of multistoried- Battery setups which has found widespread application for poultry as also for the high-priced mushrooms in many countries including India. Many such units can be found in and around Delhi for instance.

In Sri Lanka cattle of landless farmers graze under coconut trees -which helps not only the milk production but also has been shown to increase coconut production. Use of residues peels from fruits and vegetables as also Sugarcane tops are often used to feed animals as in countries like Pakistan,

Bangladesh and India.

In Barmenda, Cameroon there are around 2000 rabbit farmers. Rabbits are popular for various reasons apart from their very short gestation period of 27-33 days. [30, 31,32,33,34,35]

Another interesting report from the Ho Chi Minh city Vietnam, describes a micro hatchery producing 70 million hybrid catfish seed per year in the front room of the family home in the heart of the city. [36] This writer had seen similar production units for mushrooms in the sitting rooms of well off city dwellers, sometime in 1982 in Ludhiana doing extremely well.

In Mumbai, one of the densest populated city in the world an enthusiastic R.T. Doshi has been practicing and developing terrace gardening in Bandra the heart of the city of Bombay where he grows vegetables, flowers, pulses, fruits and cereals. He also has mango, fig and guava plants apart from some 1000 sugarcane plants.[37] Doshi has had his inspiration from Fukuoka and a local city farming promoter Prof.S.A. Dabhulkar of Bombay. Apart from any commercial or economic gains, Joshi counts on the creative pleasure and the healthy environment this creates, as sufficient gains. Another movement, the Trees for Life, an international NGO working in India has also been promoting city gardening since 1984. Starting from a village at Chittauri, in Allahabad District, it has spread out and has enlisted a number of Corporate industrial houses although the main stress is on trees, with the distribution of seeds and saplings.[38]

Bio-intensive kitchen gardening has also received support from J.P. Singh and Jerry Thomas of Allahabad Agricultural Institute, Naini (U.P.) This group has worked out a technical biointensive system for this purpose with emphasis on raised beds and compost including vermicomposting. Stress has also been laid on intensive planting, natural pest control and crop planning. Of special interest is the use of home-made pesticides based on indigenous knowledge and experience. Some of these are tobacco brew, custard apple brew., Soap spray and tomato plant extracts. Use has also been recommended of garlic, onions and pepper brew, woodash. In addition extracts of *Nerium indicum*, *Chrysanthemum* flowers, *Gliricidia sepium*, Lantana dust and neem amongst other remedies like Oscinum sanctum have been recommended. Mention has also been made of some standard commercial plant pesticide

products now available on the market in a paper presented at the Organic Seminar September 1995, at Kottayam, Kerala, India.[39] In another novel system, walls have been used in Botswana supported by a SIDA project with specially built hollow concrete blocks for manure/sand. These have proved useful for growing a wide variety of vegetables and has come to be referred to as Growing walls.[40]

As a part of the promotion of organic city farming, old fashioned remedies for plant protection are being revived even in the citadel of conventional farming— he USA. These cover double digging, which also ensures raised beds with advantages of aeration and better roots. The organic home garden-care products market in USA has touched some 5 per cent of the chemical pesticide market or some US $3.0 billions. Today garlic-based pest and disease control nonsynthetic pesticides are being registered by the US-EPA for lawn care, home garden and agricultural use. Garlic sprays are being used for a wide range of vegetables such as cucumbers. This seems to control or repel wide range of aphids, snails, caterpillars, whitefly, ants, spider mites, leaf loopers and grass hoppers. Garlic preparations are being widely used on fruit, nut and citrus trees as also vine crops. Baking powder in water is also finding use as fungus fighter.[20]

Yet another fillip to city gardening comes by way of indigenous green leafy vegetables which are time-tested and trusted by the consumers. Some of these are also excellent sources of supply of vitamins, proteins and minerals. These are plentiful in output and are almost perennial. An example of this is a vegetable jute found in Zimbabwe. This is an annual herb and is eaten as a spinach.[41] A reference has already been made to the Spinach tree (Moringa sp.) widely used in Zimbabwe.

City Farming as we have seen offers many apparent and some latent advantages. One important fallout of this is to provide struggling women in many developing countries an avenue for food and cash. In some countries the urban farmers may be men but women process and market garden products. City farming serves as a boon to women with limited formal education and training. What is possibly necessary is to help bring about a change by providing community credit to women to work in this field and possibly improve returns through value added farm products for which there is a vast market in the

affluent cities.[42,43]

Towards this end, the need for gender analysis and formation of guidelines for project planners and implementers has been suggested. This will have to take into account a wide range of socio-economic factors including the activity analysis, rights and rules for land, water, trees and other natural resources. Such an analysis including the impact of external factors on women's ability and work-conditions and environment would produce the kind of impact that is necessary in order to meet the women's pressing, neglected needs. Thus we can in the process not only promote our avowed objective of ecological farming but also fulfil much needed orientation of gender equality.

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Chapter - 14
Biodiversity, Biotechnology-food security and food safety

For reasons, good and strong, over the past few decades there has been a noticeable, gradual switch back to the indigenous old human knowledge and experience, what has emerged as alternative agriculture(AA) or ecological farming(EF). However more recently there have been newer, feverish under-currents and movements obviously initiated by the powerful agro-industry in the form of biotechnology and genetic bioengineering which ostensibly will create food security. On the surface of it, these seem very natural, normal and even exciting and welcome scientific developments aimed at eliminating hunger or even reducing the use of pesticides and other related undesirable chemicals. However on critical examination these raise some questions and concerns specially in respect of food safety. One therefore feels a bit wary and doubtful whether these are all possibly a backdoor method of retaining high(er) use of some of these very agrochemicals under the cover of banishing world hunger.

It may therefore seem almost prophetic that the Bogeve Declaration, Towards a People Oriented Biotechnology, way back in 1987 sounded a clear danger signal. The Rafi team headed by the inimitable Pat Mooney had also put forward their views and philosophies in considerable detail in the special issue of the Development Dialogue. This volume touches on the life technologies, economic laws of life, political laws of life and includes the Bogeve Declaration touching on many pitfalls behind the promises of the new biotechnology and genetic engineering.[1]

Obviously these early warnings were not heeded which had led to US-EPA permitting limited use of Bromoxynil on transgenic cotton. This herbecide was formerly not used for cotton because normal cotton is destroyed by it. The new

'normal' cotton transgenic seed is bromoxynil-resistant cotton seed from Calgene. The herbicide is known to cause developmental abnormalities in laboratory mammals and may cause birth defects in humans apart from being a potential causative agent for cancer. In addition it is toxic to fish.[2]

US-EPA had also cleared to commercialize glyphosate-resistant transgenic soybean seeds. During 1994, Agrow, now a Mexican company was among the first to gain commercial approval in USA for a genetically engineered crop. This year Agrow is offering seeds of transgenic virus-resistant yellow crook neck Squash to farmers. Use of such pesticide-dependent seeds is bound to substantially increase the use of these chemicals, adding further to the environmental problems we have already touched upon.[3] Some other threats of these genetically engineered seeds will be discussed as we go along. Union of Concerned Scientists (UCS), as also Rural Advancement Fund International (RAFI), have listed the transgenic crops indicating the sources of the new genes and purpose of genetic engineering in some 17 crops.2 A look at this data clearly shows that the avowed intention is to achieve increased disease resistance and herbicide tolerance as is already clear from the 3 clearances accorded by the US-EPA [4,5].

A wide range and variety of plants-amongst these cereals, fibers, forage, forest trees, fruits/nuts/oil vegetable and other ornamental plants including tobacco and sugarbeet have been under development using the famous patented gene gun of W.R. Grace. Some of these have already been patented world wide although others have run into problems like transgenic cotton both in India and USA. A list of some 17 genetically engineered products has been collated by UCS, a large majority of which are already in the market and seven were under clearance (as on July 1995) and one tomato variety was proposed for release in 1996. Incidentally 2 tomato varieties claimed to possess delayed ripening properties named Flavr Savr and Endless Summer had already hit the market in 1994 and 1995 respectively.[2] As of December 1995, this list has grown to 23 with several of these already available to the Industry for use.[6] This tribe has grown further to 31 as on June 1996 showing the tremendous hurry with which the powerful and resourceful companies are working.[7] Several of the products are either in the pipeline awaiting field trials or ready for market-meaning already on sale or awaiting formal and final clearance from official agencies in USA. Incidentally a year after it was

introduced by Calgene, Flavr Savr an early ripening variety tomato appears to have more or less disappeared from the market. It appears this bioengineered tomato has not been able to live up to its expectations.

At the very outset it is well to remember who actually are interested in genetically engineered seeds and crops. This will help understand the next logical question of why? From the information collated by the 4 leading NGOs RAFI, UCS, GRAIN, SAFE, there is no doubt whatsoever that it is basically the pharmaceutical-fertiliser-seed companies which are in the forefront. And one of the most dominant activity appears to be creation of crops tolerant to herbicides. A large number of these transgenic plants are under development, largely in the USA. While science of biotechnology had created high hopes for improved and better foods and pest resistance, a move away from chemical agriculture, the reverse seems to be happening- creating a heavy dependence on herbicide use through development of herbicide dependent plants.

A reference has already been made to the introduction of atleast three transgenic herbicide-resistant crop varieties. Another area where bioengineering is active is in the area of incorporating Bt genes in crops to make them pest resistant. It is argued that this will obviate the need for separate use of Bt preparation as a biological control agent.[7,8,8A,8B]

There are strong and legitimate fears that this may lead to the development of resistance to the Bt toxin in insect pests. If this occurs the genetically engineered plants will lose their effectiveness leading to the use of conventional chemical pesticides. Thus what the MNCs or the corporate agribusiness sector is doing is to create an industrial agriculture based on a severely narrow crop base, intensive monoculture and extensive inputs.

This kind of agriculture is what a large number of scientists, technologists, planners and thinkers consider to be environmentally destructive and ultimately unsustainable. Basically there are two major categories of environmental risks involved. One centres around the engineered plants themselves and the other is linked with the movement of genes into other plants found in nature. These and related issues have been brought up convincingly and splendidly by Jane Rissler and Margaret Mellon in their Perils amidst the Promise which highlights the ecological risks of transgenic crops in the ever

expanding global market. [9]

The first set of risks from the bioengineered plants is that their new traits are inducive for them to turn into weeds both in the managed agricultural ecosystem or away from this system, to disturb other unmanaged ecosystems. It is also feared that in rare circumstance these might turn into a very difficult to eradicate weed such as kudzu.

The second type of risk predicted is the possible transfer of the transgenes to related crops, especially when wild relative crops are in the proximity. Quite often these transfers take place through the nesting birds which might change their normal habitat for any reason(s).

The third type of risk is manifest when the transgene added to a crop plant is a component of a virus. This may well lead to the creation of new viruses which may either lead to severity of the plant disease or an entirely new kind of plant disease.

While the risks on an experimental basis may be small, these multiply in case of commercial transgenic crops. As it is, genetic engineering technology as compared to traditional systems is high key and intensive, with a large pool of new genes with naturally higher harmful potential at its command.

Secondly there is reason to suspect that the new transgene combinations are likely to be less stable and less predictable as compared to traditionally bred varieties leading to unexpected end results.

Thirdly strange as this may sound the transgenes as a rule control traits which are to the advantage of the recipient plant. It is feasible that these very same qualities might enable them to overcome limits on their multiplication. Further since the new attributes are controlled by one or two genes, their transfer to the wild species would be facilitated. It is further to be accepted that there is lack of knowledge and experience with transgenic plants, a situation which is worsened on account of the high degree of secrecy surrounding their development. Added to this is the factor of constant flow of new genes which might come from any source including animals and microbes ending up in plants. The exact consequences or results of such entry in the wild plant ecosystem cannot be correctly fathomed or predicted, especially in the absence of any independent framework and infrastructure.

There are also lurking doubts about the reliability or dependability of field tests and trials which are undertaken before transgenic seeds are released for commercial scale use. Under the best of circumstances there are lacunae in the field tests vis-à-vis commercial use as indeed has been observed in the case of pilot scale and commercial production of any products. Specially since there are no limitations on the movement of commercial plants and their seeds/pollen will flow unimpeded to the relatives both in agricultural and non-agricultural areas.

Further events like floods, will be another contributing vehicle for transfer. Yet another problem is that of international trade (or aid) which entails transfer of grains or even seeds to far off places and habitats with resulting possible complications and threats. It is thus questionable whether the USDA or any other national agencies are fully geared to many of these new undetermined challenges. It is therefore well that many of these risks were discussed threadbare at a Workshop of Scientists in the fall of 1991 where many of the issues were discussed in depth.[9,9A]

The resulting Report rightly emphasizes over and over again the main fears - that the transgenic crops might turn into weeds in support of which thesis the Report cites 22 examples of plants which indeed have turned into weeds in USA alone. This has also necessitated framing a definitive definition of a weed, `a plant not intentionally sown whose undesirable qualities outweigh its good points'.

The other major risk with large scale releases of transgenic crops is that the transgenes in crops will be transferred by natural means to other plants, turning them into weeds or the phenomenon of 'gene flow'. This in effect may mean changes in plant communities and possibly to reduction in biodiversity as also general threat to habitats of diversity .

The third risk is the likelihood of new viral strains and altered host range that may come up from the frequent use of some of the engineered - virus resistant crops.

Apart from the above well reasoned and likely risks, there is always the world of unforeseen and unknown risks and this is not far fetched when we observe the scientific scenario.[9B]

Take the example of breakdown of penicillin, yesteryear's wonder drug which became nearly extinct, in part due to the

resistance of the hitherto susceptible organisms into resistant ones. Same is the case of emergence of the phenomenon of resistance and resurgence of pests to pesticides or virus-resistant crops. And pray who had foreseen the phenomenon of global warming or the phenomenon of a hole in the ozone layer? Such examples both from the past and the present could easily be multiplied. In the background of these weighty and serious concerns coming from serious-minded, knowledgeable persons of perception and foresight, it seems clear that no country can lightly brush aside this wisdom.

It is therefore obvious that a number of steps and actions are imperative nationally and globally for assessment and minimization of the risks of transgenic crops before these are commercialized. The new transgenic crops need to be critically evaluated, before release- first of their weediness potential and gene flow before being cleared for commercial release. This must also cover possible risks. Special care needs to be paid to assess the risks of creating new viruses, non-target effects of pesticides and eco-toxicity of plant pharmaceuticals. There are also strong reasons for a setup to assess all possible risks of genetically engineered crops. The UCS in fact calls for a study of impacts of genetically engineered crops not only within a country but outside where these are released and a clear labelling on transgenic seeds exported outside the country of origin.[2]

There is already a serious concern on the US-EPA decision to allow Bt potatoes commercialization. This means that these potatoes will produce an insecticidal toxin obtained from the soil organism Bt. In the wait are Bt-corn and Bt cotton crops. Apart from the serious problem of the possible development of insect resistance which is frightening, there is also extreme concern in respect of human health and environment since Bt will find its' way into foods, the possible movement of Bt genes to other plants in the environment which might turn into weeds and the resulting non-target effects of these crops.

Thus the time has come for a serious confrontation between the public interest groups and those who are going ahead pushing to make profits through quick gains taking advantage of the general trust and confidence of the common citizen and their unpreparedness to meet these challenges.

It was therefore a welcome development that Biodiversity

received a great support at Rio de Janeiro in June 1992 through adoption of the Biodiversity Convention despite several limitations and watering down by the US. The genetic base of agriculture the world over has been under threat for a variety of reasons especially with the rise of industrial agriculture. While there have been debates on ways and means of introducing wild genes into our agriculture necessitating need to maintain biodiversity and gene banks, the genetic base has generally been shrinking following wide-spread monoculture agriculture.

The biodiversity of agricultural systems is a fundamental step in fighting rural hunger and conserving vastly depleted and endangered genetic resources. This is exemplified by the role of farm women in Brazil.[10] Likewise conservation and utilization of world's biodiversity, according to Rafi is the cornerstone of global food security. As the stakes are rather high for the South countries and these and related matters should have received the highest priority at the recent World Food Summit at Rome.[11] Rafi had also drawn up the Biodiversity Balance Sheet which also came up for discussion at the Leipzig Conference held in June 1996.[12] This dealt with, amongst other issues with food security, diversity and dignity in the nineties in the background of various contexts, issues and strategies.

As has been brought out, the community rights are closely related to biodiversity and intellectual property rights, which deserve to be linked to heritage.[13] In this connection it is equally necessary to link up the hidden harvest of wild foods that have been traditionally used by the indigenous people world wide.[14] It has thus been rightly argued that in view of the importance of the subject matter, the biodiversity in agriculture presents a political challenge especially to the affluent countries who need to recognize and gracefully acknowledge the role and contribution of the developing countries now abounding with teeming and needy resource poor farming communities who need to be gainfully involved in the management of plant genetic resources.[15,15A]

It is therefore of interest to note that on 18.5.1995 Philippines has taken the lead for control of now unrestricted bioprospecting by requiring that prospectors henceforth may enter an agreement with the authorities. Better late than never.[16] This point of view is further elaborated by Jean Christie of the Rafi group which makes a North/South analysis of the

issues, particularly in the background of the neglected rights of the indigenous people in Australia. The analysis draws heavily on the Biodiversity Convention adopted at the Earth Summit in July 1992 and asks for the needed corrective steps and actions.[17] In yet another timely study, analysis has been made of the benefits of biodiversity, highlighting the benefits harvested by the North Industry from farmers of the South through use of agricultural and medicinal plant species nurtured by them over the millenia.[18] A related study was also made by Jenkins earlier.[19]

While biotechnology may result in new varieties, the enormous costs involved on R and D seem to necessitate widest and maximum use of the new developed varieties. The consequence of this would be the replacement of several earlier varieties in use, resulting in reduced biodiversity. In fact the well founded fears are that the increased use of such narrow, homogenous varieties may well provide the maximum possible opening for genetic adaptation by pests, diseases and weeds. In other words this may well provide ideal conditions for self-destruction by these very same pests, diseases and weeds, following the completion of such adaptations.

Thus genetic engineering and even plant breeding carried out in isolation may be of no avail or advantage. This in effect means that biodiversity is essential to the success of genetic engineering as a method for plant breeding and not vice versa. In fact genetic engineering has been named as one of the nine important causes for loss of biodiversity. This is because in theory genetic engineering is an effective and reliable tool but in actual practice the newly engineered varieties are likely to accelerate the replacement of existing varieties.

There have also been serious concerns over biotechnology, which for profit making firms means money- making and leads them to search for large scale exploitation of natural resources, species, microorganisms, wild strains of plants and animals as sources of genes. These are now being used to develop chemicals, drugs, foods and several other products some of which are farthest from our thoughts and comprehension. And this is a big untapped market, one which the private sector is intent on expanding from about US$ 5 billions to some 50 billions by 2000 AD. As per RAFI, the third worlds' genetic resources have already added US$ 5 billions to the agro-economy of the North countries.[7,8]

Biotechnology involving DNA recombination, the power behind the Green Revolution had destroyed or obliterated many native strains especially in rice and wheat. Some 1500 wild varieties of Indonesian rice are estimated to have been lost. The story is same elsewhere if not worse.

RAFI have also been drawing attention to the plant plunder and it is estimated that some 60,000 species may vanish by 2050 throughout the globe. This will be about 1 in 4 of the worlds' total which could be extinct.[20] Many of these plants as already indicated earlier are of insecticidal value and more importantly these form the back bone in indigenous systems of medicine- the Ayurveda, Unani and Sidha in this country and other indigenous systems elsewhere. Some of these are gaining importance now for diseases such as AIDs, cancer, arthritis and many more ailments some of which are almost intractable. Many of these vanishing species are already under the negative list of exports or on the Red List of Banned Species or some of these have since been declared extinct.

In a report, Manoj Bhatnagar refers to the unprecedented pilferage of medicinal plants from India and he cites many such examples including some threatened Rare plant species.[21] Same is true in case of number of indigenous cattle breeds used for agriculture and transport, some of which are threatened and near extinction even though they have found renewed uses for agriculture and as food in the North and South America.

RAFI[22] refers to piracy in medicinal plants by large pharmaceutical companies who are scouring the earth for valuable medicinal plants. One such successful example is that of serpasil for heart, reportedly taken by Ciba from the enormous land of the Governers' Estate in Madras. This NGO which has been crusading in this area has provided details of the Biopiracy world-wide and given details of the firms involved.

In its September/October'95 issue, RAFI gives updated details of these activities which show that annual value of medicinal plants used by North from South is 32,000 millions US $. Another recent estimate puts the undiscovered value of plant-based pharmaceuticals in tropical plants alone at US $ 147,000 millions.[23] These genes of plants, animals and micro-organisms which come largely from the South are the strategic genes, the "raw" material for the development of new foods, medicines, fibers and industrial products for use locally and for

exports to the "backward" South countries.

Added to this are the real dangers and threats from the three main, serious flaws of weediness, flow of novel genes to wild relatives, leading to new weeds and lastly the appearance of new viruses from virus infested material. Narrowing down of Biodiversity shows the trends and the dangers ahead, the world over. Such a situation really means a setback to those who have been working towards the long sought after goal of indigenous ecological farming with a diminishment if not the end to the self poisoning of man and environment and ecology and in fact the Earth. These are therefore some of the flawed promises of genetic engineering and one wonders whether what a few committed and determined groups such as Rafi, Grain, Union of Concerned Scientists (UCS) amongst others are doing, will carry the day and convince the policy and decision makers of the serious and vital dangers involved- which they can ignore only at serious risks to the mankind future generations.

It is in this background that pharmaceutical firms are now bidding for the well stocked Botanical Gardens in their countries, which are rich in material largely on account of their free and unfettered access through their earlier empires and kingdoms in the developing countries specially in the tropics. This will be a knockout blow aimed as it is at the spirit if not the letter of Biodiversity Convention.[24] Similar concerns at the almost organized biopiracy have been highlighted by Rafi in its Overview on Biopiracy report dealing *inter alia* with problems of Intellectual property rights.[25,26]

It is these situations and thinking which had led Hope Shand to bring out her missile, Patenting the Planet. [27] These concerns have been further examined & analysed in her outstanding Resource Kit-Enclosures of the Mind.[28] Considerable concerns still persist in the field of trade related aspects of intellectual property rights (TRIPS) and with determined attempts on patenting life itself. [29] These issues have also been analysed and highlighted in a paper dealing with the complex problems of what it refers to as the Life Industry, which is in the grip of giant transnationals.[30] It should therefore cause no surprise that there are equally serious concerns in the third world, including India, on the future of our seeds and the farmers themselves.[31] Protection of our biological and intellectual heritage in the background of organized piracy is yet another area of concern as also issues

relating to globalisation of industrial agriculture involving heavy social and ecological costs.[32,33]

The highly controversial Gatt-Trips propelled patent rights were thus a subject matter of a 2-day Conference at New Delhi which was sponsored by some of the leading parliamentarians, cutting across party lines.[34] How the developing countries were being pressurized or is it bullied by some of the industrial nations has been examined critically in relation to GATT related Trips in relation to 1978 Convention on Protection of New varieties of plants (UPOV) in the background.[35] There have been several reports indicating anxiety over genetically engineered (GE) products. Some of these GE-products are resistant to herbicides or to insects or to viruses. These situations, it is feared, may lead to problems at not too distant a stage as the present limited experience clearly demonstrates.[36] Attention has already been drawn to the association of OP insecticides to heart diseases which was first shown way back in 1966 and 1984 by Indian scientists M. R. Limaye and H. N. Saiyad and coworkers and which are now confirmed in U.K by Care Alan.[37]

Cases of infertility and several other health problems have also been demonstrated. It has also been reported, conversely, that living on organic food appears to double sperm rates.[38] Fears have also been expressed on association of pesticides, with U.Ks' mad cow disease (BSE), which were being compulsorily administered in the form of phosnet with the base of the ill-fated drug thalidomide. Exposure to OP pesticides also seems to lower immune system both in animals and man.[39] In a new devlopment Michael Purdeys early observations for a possible link between mad cow disease/OP link seems to have found support for further research.[40] Now an Investigative journalism, reveals a possible link between BSE and methyl bromide.[41]

In UK, GE-maize has been cleared for use in food products. This product has been modified to resist Basta, a Hoechst pesticide, glufisonate ammonium and antibiotic ampicillin. Incidentally European Union has chosen to ban GE-maize as a crop.[42] Some other GE-products cleared so far are Flavr Savr, Biomato, rapeseed[43,44] and Soybean which is resistant to Roundup(Monsanto' weed killer glyphosate).[45] A detailed and a worrisome report on soybeans has also been brought out by the Greenpeace.[46] It is also a matter of concern that India should have decided to import some one million tones of GE-

soybean from USA, unmindful of the world-wide concern in the matter specially in UK & USA itself.[47] Release of genetically-modified foods such as soybean, maize and many others, without labelling, apart from being fought with inherent dangers, also leave no option to the consumer on what he prefers.[48] In the meantime the Vegetarian Society of U.K has banned the use of GE-Soya and other similar products from foods approved under their symbul.[49] In UK, Monsantos GE-Soya has been given a clear warning on account of established presence of phytoestrogens, higher levels of fat in soya-fed cows apart from its dependence on glyphosphate.[50,50A] The Phytoestrogens in Soya formulas have been under a cloud for long for their possible role as endocrine disruptors. At last the British Govt. report is expected to be released in Nov. 1998.[51] There is similar fear that the GE-crops may harm beneficial insects in the fields.[52] Another study of GE-soybeans incorporating Brazil nut proteins has shown that the modified soya acts as an allergen. Thus allergens can be transferred with GE-products.[53] Similar detailed studies have also been carried out by Beth Burrows at the Edmonds Institute.[54] Fears that the GE crops may pass on their ability to resist pesticides to wild species may be well founded according to Danish studies. Experiments on rapeseed seem to suggest such a situation through pollinated wild plants within 2 years.[53] A recent alarming report from the UCS regarding failure of the GE altered cotton crop failing in the fields of Texas and elsewhere in the USA should make all concerned to sit up and take stock, before it is far too late.[55] The earlier UCS report find confirmation from other recent reports.[56,56A] That these fears were not imaginary is also borne out from recent development of "Terminator" genetic seeds now patented by none other than Monsanto, a multibillion MNC with tentacles spread around the world, including India. These altered seeds will not germinate-which means every farmer rich & poor must purchase these from Monsanto.

The serious debate & concerns follow. This technology is expected eventually to cover all seeds, starting with cotton & soybean. This has serious, earth shaking consequences & need to be challenged headlong by all well-wishers of the Universe.[57,57A,58,58A,59] One welcome off-shoot of this has been the building up of collective pressure on Monsanto to withdraw its, finalised plans for setting up of a joint R&D centre with Grameen Bank of Bangladesh. This has been reported by Karen Oon-Buffin of Christain Aid, London.[60]

With such overwhelming evidence and clear pointers it is hardly surprising that there is today a world wide concern, specially amongst enlightened consumer groups. These have found expression for instance for finding answers to the problem of feeding 10 billion mouths by 2020 without use of agrochemicals.[61]

In a penetrating expose' Nzamujo working on Songhai Project in Benin, highlights the problems of pursuing sustainable development in an unstable environment. The writer has identified 5 main constraints which may explain the economics and the crisis facing the social forces at work to remedy this situation.[62] Similarly threats to community food security, towards sustainable food and World Food Summit(WFS) and Food Security form a well thought out, pragmatic and challenging subjects in the recent 3 World Sustainable Agriculture Association Newsletter.[63-65] Possibly the sum total of this thinking on Food security with Food safety is well wrapped up in the Proceedings of the International Conference on Human Health and Toxic Chemicals organised by Green Network at the University of Warwick, UK, 26-27 July 1996. The Conference attended by a large number of scientists, leaders and public interest groups from the North has made a fitting and a stirring 12- point call for the Governments and International agencies who gathered at Rome in November 1996 for the WFS to help move towards safe and sustainable farming systems.[66]

While the World Food Summit organised by the United Nations Food and Agriculture Organisation (UN-FAO) which met at Rome 13-18 November 1996 has come out with a Rome Declaration on World Food Security and a Plan of Action, amongst the many non-official participants and observers there appear to be few takers.[67-70] This is quite clear from the FAO report which seems to accept that the follow up on the WFS would be a formideble task resembling new mountains to climb.[71] Recent three reports from IIED,[72-74] touching on rural-urban interaction & livelihood strategies, empowerment and sustainable livelihoods, should therefore be a cause for deep pondering. It is also a welcome sign of recent awareness that a national workshop was held at Lucknow in March 1998[75]. All these should provide both food & fodder for our thoughts & timely action. According to the lofty WFS plan, the number of people who suffer from chronic hunger and malnutrition will be halved from the present 840 millions by the year 2015. However this also means increase in world food production

by 75 per cent in the next 30 years.

In so far as this country is concerned, there have been serious food shortages in terms of wheat recently and the Government under pressure has had to reveal the fall in total food production by 2-3 million tons during the last two years. In this background the wisemen of the world specially in the chronically deficit food areas must re-consider the alternatives afresh rather than rely on the WFS declaration and Plan of Action alone. Past, recent and present experience in Asia and Africa fully warrants such a hard headed and a pragmatic approach.

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Chapter - 15
Summary, Conclusions and Looking ahead

An attempt has been made to briefly examine, analyse, various aspects, angles and dimensions especially the lurking doubts and emerging concerns involving the use of pesticides since the mid-forties particularly with a view to see whether their dispension will in any manner weaken food security also remembering the serious contamination of the environment and the food these have brought about apart from manifold health risks.

As a background an attempt has been made wherever possible to look into the traditional, indigenous pest control measures and practices around the world and in India practices which have been elbowed out yielding place to chemical pesticides.

As we have attempted to show through various concrete examples, there is increasing concern world-wide over the many serious consequences associated with the use of these highly toxic chemicals. For instance very minute quantities as low as 12-700 milligram of an organophosphate, could be fatal for a 70 Kg. weight person.

The Health Hazards

Over the years more authentic data has been accumulated which clearly shows the many adverse effects on human health- some of these are the induction of male and female sterility, irregularities in fertility, abnormalities in children, the serious threat of cancer particularly in children and women, disorders of circulation, brain cycle changes and imbalances and other neurological abnormalities. If this was not enough there are reports of disorders of the immune system and changes in bone marrow apart from causation of diabetes, allergic and inflammatory effects on tissues.

Organophosphate and carbamate pesticides which are

now in greater use and in ascendance on account of some advantages they seemed to offer are unfortunately potent inhibitors of acetylcholinesterase (AChE) which prevents the breakdown of acetylcholine which builds up in the brain and in peripheral synopses. This is believed to lead to significant depressive, neuralgic and cardiorespiratory symptoms.

Quite often the reduced AChE is not detected by the attending physicians leading to serious distress. It has also been reported that AChE inhibitors may pose a greater risk to human health in the Third World countries where poor nutrition is quite often the case. These observations are based on laboratory studies which indicate that the hepatic enzyme activity of animals with protein deficiency, was more susceptible to the administration of malathion, an OP pesticide, than that of well fed animals.

Malathion also caused a decrease in liver protein and lipids in experimental animals. Cases of asthma have also been linked with exposure to OP pesticides. Although the significance of these findings to public health cannot be easily evaluated, the portents/ indications are quite clear and alarming especially considering that some 6 million tons of pesticides are being spread, on fields, every year over the globe. In many reported cases the farmers even though suffering through the use of pesticides while spraying as a profession, have no choice for sheer survival.

Even conservative estimates by the WHO indicate that about 20,000 pesticide poisonings turn out to be fatal each year globally. In countries like India these figures are mere guesstimates since regulations even where these exist are followed more in breach than in practice.

Poisoning the environment

The havoc caused is not limited to only human life directly but in various other forms including the insidious poisoning of soil, water both rivers and seas, including drinking water and air. In addition this has led to extinction of useful plants and animals, loss of biodiversity, not to speak of pesticide-resistant pests both plant pests and human disease vectors and also seriously disrupted the ecological balance, leading to irreparable damage to ecology. These issues and many more, including socio-economic losses have been brought out in the appropriate sections.

Indigenous pest control over ages and its neglect

Briefly, the history of the use of pest control agents has been traced to 2500 BC by Sumerians to fight insects and weeds. It was perhaps the Egyptians who introduced large scale plant hygiene methods such as crop rotation followed by the use of follow methods in Roman times. Similar work of Indian and Greek scholars was taken up by religious leaders in Eurone and in the Middle Ages.

Apart from other indigenous methods and practices, applications of tobacco for instance has been practiced for thousands of years.

As has been brought out these have since emerged as natural crop protection methods and practices which could be placed in the categories of biotechnical, chemical, biological, physical and cropping technical methods evolved by man over the centuries using his instincts for self-survival.

An attempt has been made to highlight the neglect of these successful indigenous technologies world-wide especially after the entry of chemical compounds during World War II. It is this situation which led to the present grip of chemicals on agriculture with its' now manifold negative traits and scenario arising from second generation pesticide use. This in fact discarded not only the ancient crop protecting systems but also the indigenous technologies recorded by Voelcker, Albert Howards, C.C. Wilson, F. Keating and recently in India by Winin Pereira.

Development of Pesticide industry

Touching on the advent and development of the chemical pesticide industry in India and world-wide a formidable 26.8 billion US$ industry shows the problems created, including associated vested interests, and other formidable constraints in introducing alternative safer, non-pesticidal methods.

It has been brought out that while pesticide use and expenditure has jumped many fold as high as 1000% in USA, this has not been accompanied by corresponding gain in protection of crops from pests for a variety of reasons.

The introduction of chemical pesticides in fact came via their use first in public health control and came to India via the British tea and coffee planters without any check and control.

Further there were no records much less a method of notification of ill-effects including poisoning and death especially since the affected workers were quite often migrants, seasonal employees. This situation was further compounded by the illiteracy, lack of knowledge and poverty of the employees.

Development of Regulatory Systems

Although a 1952 Agriculture Poisonous Substances Act did apply to the field workers during spraying operations, it was the 102 deaths in 1958, first reported from a British Army Camp in Kerala State that stirred the Government into action leading to the enactment of the Insecticides Act in 1971, which followed the Shah Commission Report (1958) and Thacker Committee Reports (1967). While a whole range of regulatory acts and regulations have been enacted and framed in the country, these suffer, as has been pointed out from lack of implementation, indicating and calling for the active entry of public interest bodies and groups as is the case in the Western World.

A comparison of the Indian regulatory system has been made with that obtaining in countries like USA and UK. Brief details of practices in 18 OECD countries and Mexico as examined and analysed by US-GAO have also been presented especially aimed at harmonisation of regulatory practices under the GATT Agreement. An attempt has also been made to bring out the vital role played by the Delaney Clause of the US Food Drug and Cosmetic Act which had in effect barred the entry of several new pesticides feared to possess carcinogenic activity. It emerges that the US perhaps has the most highly effective pesticide regulatory system anywhere in the world.

The implementation of insecticide regulations, with a shift towards biological control agents and plant pesticides has been brought out as also the banned, not approved and restricted pesticides. A reference has also been made to the use of different types of pesticides and production capacity etc., of this over Rs.10,000 million lethal industry in which the public sector has an important share being preferentially located in so-called, backward tribal areas in the country. The data has also been presented for some 34 pesticides in use in the country which have been banned or restricted in many other countries as also the rising quantum of exports specially to the Third World countries.

Review of pesticides in India and elsewhere

Reference has also been made to the appointment of the S.N. Banerjee Committee in 1984 to review and recommend safer substitutes for pesticides which had been banned/ phased out in their countries of origin.

The Committee first met on 26.10.84 and the now infamous Union Carbide disaster at Bhopal which has since claimed 3000 lives and tens of thousands of affected victims, gave it some urgency. Even then it completed its task only half-heartedly by 1991. However, some of the recommendations, even though diluted have not found favour with the Government and has been acted upon in fits and struts after long delays as brought out in the Action Taken report on the subject in 1994.

This information incidentally if incorporated in the PANs now well-known and famous Dirty Dozen Campaign Chart (1995) would make it look less "dirty" in so far as India is concerned despite all the delays. In the light of this background an attempt has been made to examine, analyse and understand the reasons or the causes of opposition to pesticides. In this task we had to have a look at the reasons(s) which led to the stand taken by the marine biologist Rachel Carson which are now universally accepted to be scientific and logical despite the earlier opposition it attracted.

Why Opposition to Pesticides?

The fears expressed earlier are now being confirmed that the use of pesticides are closely intertwined with health risks especially for users and applicators, factory workers as also soil, air and water world-wide. There is hardly any place in the globe, including the oceans, rivers, underground waters or even fog, rain and dew drops or snow as far away as the Arctic, where pesticides have not gained entry. The same is true of soils, farm products, air, fish, animals, birds, wild life and humans.

In simple words since human life is the centre of our attention and concern, the entry of pesticides has led to the poisoning of man from a large variety of sources. Pesticides have contaminated foods and jeopardised normal human functioning and enhanced the health risks and have penetrated the food chain. This situation has been further aggravated on account of the widespread use of pesticides

for grain storage by small farmers and extensive and frequent misuse by fruit and vegetable vendors.

Reference has been made to pesticide residues in foods, water, animal milk and not to forget human mothers milk where these are now found in abundance, far in excess - anywhere from 0-1000 times higher of even the legal standards. This, as has been pointed out is particularly disturbing in respect of third world countries where the nutritional levels are low , amplifying the dangers.

The same is true in case of dangers to growing children as has been brought out in a number of scientific controlled studies. One could only wish that this was the end but a rather formidable danger comes from the resistance developed in plants, pests and vectors of human disease apart from the phenomenon of resurgence. This apart there is a negative impact on biodiversity and threat to the ozone layer.

All this has led to bioaccumulation and environmental persistence. The use of so called inert ingredients used in pesticides have also been found to add to their toxicity specially when used in sprays. Some of the isomers of pesticides which come as contaminants in the production process have turned out to be far more toxic. In addition the breakdown products of these products in some cases are far more lethal and to this are the added risks posed on account of the synergistic action of these permutations and combinations. All this also poses the insurmountable problems of finding suitable antidotes for treatment.

Poisoning of Earth and Man

Reference has been made to the dangers arising from aerial spraying in enclosed places like aircraft and use on pets and for control of head lice. Pesticides also interfere with pollination through the destruction of bumblebees and honeybees apart from soil organisms particularly the earthworm, as is clear from a number of surveys and studies conducted world-wide.

What has seriously alarmed the world is the linkage of pesticides to cancer in a number of confirmed, controlled studies apart from recent studies which go to show that the OPs mimic estrogens and other hormones in humans thereby hampering reproduction and development process in both females and males, including abortions or premature pregnancies in females.

In India many of the pesticide poisoning cases were meticulously looked into and reported by the Thacker Committee itself. Apart from other cases of callous neglect, it has been brought out that no standards have been laid down on pesticide residues and limits in water, air or animal feeds. Further, of the 126 pesticides registered and in use, residue limits have been prescribed, incompletely, for only 50 so far.

Water contamination with pesticides is almost universal stretching from the Ganga, the Jamuna to the Great Lakes in USA, the famous Po river in ancient Italy, the North Seas and the Antarctic. What is different is the level and range of pesticides found.

Some of these concerns have been accelerated with the incidence of mad cow disease. Some claims, unsubstantiated, ascribe this in part to the lowering of body resistance created by pesticides in diet and body. Yet another concern is the problems created by pesticides e.g., statutory pesticide use in sheep dips in some countries like UK and it has been reported that these pesticides are linked with the causation of human heart ailments. There are also several cases of occupational health hazards to factory workers apart from other dangers on account of accident and fires in pesticide factories, an extreme example of which was the accident at the Union Carbide factory at Bhopal which has caused untold human suffering. In a number of cases pollution of water has occurred as a result of inadvertent and/or deliberate callous discharges in the waters from factories or sometimes from run-off water from fields. The studies conducted in UK for instance show the impossibly high, uneconomic costs of purifying such water from pesticide contamination. Special attention has been drawn to the practice of aerial spraying of pesticides, which really hardly reaches the target but contributes greatly to the environmental hazards including ozone depletion and global warming.

It therefore clearly emerges that the damage caused by pesticides, one of the most lethal group of chemical compounds produced by man, have a rather vast range and scope for causing damage, both open and latent which ranges from human health to effects on organisms beneficial to man specially in farming, on account of their non-selective properties. There are other changes such as in the composition of plants, such as increased level of nitrogen as in case of maize/

rice leading to enhanced infestation and danger from aphids and rice stem borers respectively.

Likewise higher concentrations of organic ingredients like amino acids have been shown to result in increased damage from various pests. In other words there is evidence to show that essentially pesticide use has led to reduced resistance of plants to pest attack. These are some of the cumulative dangers that have surfaced over sustained scientific experience over the last 4-5 decades since pesticides were first introduced for control of vector borne human diseases with considerable success during and after World War II.

Persistence of Pesticides

Surveys of soils everywhere have shown an abundance and accumulation of pesticides, years after some of these have been discontinued, on account of their long half-life, despite questionable claims of their faster breakdown under tropical conditions. Added to this is the problem of breakdown products itself, some of which are even more lethal. Further different kinds of these chemicals may come together in soil leading to far more hazardous synergistic combinations. Some of the relevant data has been presented in the text with specific examples. These findings are now well established not only for soils but also for water, indicating increasing incidence of pesticides in water over the years.

Problems of Resistance and Resurgence

Reference has been made to the increase in the resistance of plant pests as also in vectors of human diseases which has assumed alarming proportions. Unfortunately on account of the limitations of R&D and effective surveillance, there is inadequate information in this country which seems to create a rather erroneously rosy picture and shuts us off from the real dangers. While upto 1987, some 447 resistant species were reported from USA, in India, upto 1993 only some 18 pesticide resistant varieties had been reported. Likewise it is only recently that the problems associated with the phenomenon of resurgence to pests is beginning to be understood and appreciated.

It is these and other related concerns that led to the launching of the Dirty Dozen Campaign by the especially constituted Pesticide Action Network by the International Organisation of Consumer Union (now Consumer Internation-

al), Penang an effort which has successfully drawn both public and official attention to the manifold problems created by pesticides.

In fact it is these wide felt concerns which has drawn attention to seeking alternatives to pesticides leading to the development of concepts and technologies such as integrated pest management, organic farming and several other ecological farming systems all aimed at pesticide reduction and hopefully eventual complete elimination of its use. In this connection detailed studies pointing towards the enormous, mind-boggling socio-economic costs of pesticide use have been, a source of positive support.

Apart from the rather serious problem of resistance in pests, attention has been drawn to two types of resurgence-both of the target pests as well as of the unimportant non-target pests. Many of these problems have been traced to widespread mortality of natural enemies, reduction in competing pest species and several intricate related causes, once again encouraging increased attention towards alternative remedies.

The evidence that the use of high yielding variety seeds, higher doses of fertilizers, increased irrigation and pesticide use altogether cumulatively have precipitated resistance particularly in insect vectors of public health importance, leading to the appearance of pesticides in bovine milk has been causing concern. The problem of resistance covers today not only the pesticides but even the juvenile hormones, diflubenzuron and even strains of promising biological control agent, *Bacillus thuringiensis* apart from causation of multiple resistance in a number of vectors and even some fish varieties and rodents.

A high level resistance in malaria vectors has necessitated the development of malaria vaccine, since developed by scientists in Colombia. After initial promise, the vaccine seems to be now facing problems, delaying its' field use. So serious has been the pesticide poisoning problem especially on account of lack of an infrastructure that Unido-Who-Searo joined with the All India Institute of Medical Sciences, New Delhi to belatedly set up, poison control centres. Only one has been set up so far at New Delhi with very limited funds and scope despite frequent large-scale mishaps as at Basti, Uttar Pradesh.

Advertising and other Constraints in finding alternatives to pesticides

In spite of such a serious situation, instead of taking steps to train, educate and inform farmers, applicators, factory workers and the public, using the media, schools and other avenues, pesticides continue to be heavily advertised on the media. This quite often is in contravention of the FAO Code on Pesticides. In fact a rather strange incident has shaken the professionals on account of a virtual ban on screening on TV a training and information video, the Killing Fields, produced by a Department of the Government of India itself through an NGO. It seems in the unethical and undesirable promotion of pesticides, the manufacturers both multinationals and the indigenous- have a common cause often referred to as Profits from Poisons, notwithstanding the International Chamber of Commerce Code of Practices. Many such powerful campaigns conducted in the Third World countries have already been brought to public notice as in Guatemala and Malaysia.

Sustainable Development

This brings us to the present day concept or philosophy of sustainable development a common global phrase which has emerged from the thrust of the World Commission on Environment and Development (WCED) after its creation by the UN General Assembly in 1983 and its' adoption in 1987. This set clear priorities, goals and objectives in Our Common Future document towards reaching out for these lofty, but urgently needed aims and objectives set forth by the WCED, headed by the lofty thinker Gro Harlem Brundtland, a former Prime Minister of Norway.

Essentially sustainable development has two main components the essential needs of the worlds' poor and the limitations created by technology and Society on the ability of the environment to fulfil these demands. All these now form part of the Agenda 21 adopted at Rio in 1992 which has led to formation of a Commission on Sustainable Development (CSD). This in turn had its base in the Den Bosch Declaration on sustainable agriculture and rural development (SARD) in 1991.

However, much of the credit goes the to US Government agencies especially the National Research Council(NRC) which initiated a scientific, and a systematic movement and a programme towards evolution of alternative agriculture in 1984.

While some isolated, disjointed efforts have been made in India in this area, one cannot really pinpoint any well planned and organized plan of work towards this end. However, it appears to be the Department of Science and Technology's 1987 Status Report which perhaps for the first time placed the various developments in a clear perspective and sought to focus attention on the problems pesticides posed to the consumers bringing out a suggested list of alternatives as practiced world wide.

A declaration of scientists who met at Ottawa in 1986, pledging themselves to promoting sustainable agriculture has helped in this direction as also recommendations of the meeting of the non government organizations (NGOs) at Stoneleigh, Warwickshire in 1993 which in effect covers the guiding principles set forth in Chapter 14 of the Rio Declaration in respect of food security and food for local needs taking precedence in our planning and thinking.

Development of alternative agriculture (AA) has received particularly strong backup support from Natural Resources Institute, Rodale Institute, the Land Institute, the Universities of Kansas, California apart from several other Universities and Institutions like Iowa, Oregon in USA, CIAT(Colombia), Soil Association (UK) amongst many others world wide. This list is only illustrative and by no means complete. In fact this support is the sum total of all the references numbering nearly six hundred cited in this publication.

Sustainable Agriculture in Practice

Many of the thoughts behind SA have found a practical echo in the form of AA as promoted by the NRC through many organised, large-scale trials on farmers fields. These sought to establish, on a scientific and controlled basis, the various theories and practices of AA, including the concept of IPM which possibly is a step short of the full blooded ecological farming. The work has encouraged farmers to think and act independently and possibly break from the shackles of earlier years, knowing fully well the pros and cons by judging at first hand the results of 11 case studies which have been referred to briefly.

While the United States Department of Agriculture was keen on promoting AA or SA, it emphasised that this was not a break with modern or what is being called now as conventional

agriculture. Nor was this meant to be organic or ecological farming. However, it was the intention to lay stress on crop rotation, tilling practices, fertility and pest control.

Integrated Resource Management (Third Generation Extension)

The main idea or concept was to develop practices and philosophies of an Integrated Resource Management that looks at the farm as a whole. The main emphasis of USDA appears to have been the cost-benefit equation, productivity and efficiency and this sought hard data for future planning and directions. These have led to several NE Agriculture Universities in USA embarking on well planned experiments in the farmers fields. The results of these trials at Kansas for example go to indicate improved returns from alternatives as compared to the conventional systems, indeed a shot in the arm of the protagonists of AA. This has found practical support in the form of various manuals/guides and other extension help, considered to be third generation extension, helping to elevate agriculture to the old heights of yester-years, with these new approaches and strategies creating newer knowledge and technologies.

Second generation extension had assumed that farmers cannot solve their own problems and need to rely on extension workers for these solutions. The third generation extension philosophy on the other hand accepts that farmers already possess considerable knowledge and seeks to strengthen these and encourage farmers. There is no spoon feeding and instead this relies on learning process. Thus this also calls for major changes in extension education aimed at improving the skills of listening, observing and sharing in a rather self-effacing, modest manner.

Learning from the Past

The ecological systems now under development in a improved scientific environment should thus have improved their survival power over the future. For this purpose we could use the ancient knowledge, including the recent archaeological evidence of Hohokam (USA) dating back to alteast 500 - 1450 A.D. which seemed to have combined and blended agricultural and environmental systems. This involved complex and intricate canal systems, use of trees etc., all aimed at assuring food, fibre, fuel and building materials for a growing population, which enabled them to survive 1000 years in a desert.

Obviously, Hohokam had fine tuned and adapted the strategies for providing a stable subsistence and stable food supply on a sustainable basis.

While speaking of the Hohokam example and the knowledge and wisdom of earlier civilisations, a reference may be made to prehistoric, ancient Hawaiian aquaculture, also developed by the indigenous people which combined fish production, animal husbandry and agriculture all in one operation, making it truly sustainable. While even in 1778 there were 360 fish ponds yielding some 900,000 kg. fish yearly, these have reduced now to 7 ponds.

Reference may also be made to the record of 40 centuries of permanent sustainable agriculture in Korea, Japan and China without present day dependence on non-renewable sources of energy from petroleum products and other chemical inputs.

Some novel ideas and concepts have been injected to render agriculture truly sustainable which includes the no-till method of plowing every 3-5 years, use of mixed polyculture of perennials aimed at reduction of top soil loss. If these succeed, firm and fresh foundations would have been laid for ensuring safe food supply to the worlds frighteningly bulging population, apart from other benefits including employment and income generation and nutrition at affordable prices to the threatened and needy.

Development of Integrated Pest Management

As a part of the concept of sustainable, alternative agriculture, obviously as a half way house between ultimate ecological and the present day conventional farming, considerable inputs and developments have taken place in the area of integrated pest management(IPM).

IPM aims at optimisation of pest control through various treatments, employing physical, chemical, mechanical, cultural, biological and educational means in order to prevent excessive damage to crops. This system is tailor-made and not pre-determined and essentially results in reduction in pesticide use through timely alternate actions, inputs and strategies. IPM combines genetic, biological, agronomic and chemical approaches.

The importance of effective control can best be judged

from estimated global farm losses due to pests, insects, nematodes, diseases at around US $300 billions each year or some 30 per cent of the potential world food, fibre and feeds.

As per one estimate, annual losses in grain crops alone exceed the food grain deficits of the Third World. And the world expenditure on pesticides today is around 27 billion US $.

Considerable success has been achieved with IPM specially in rice, which is the staple diet for some half of the world population, grown in 148 million ha of land world-wide and 132.6 million ha in Asia. The efforts of FAO in the area of IPM in rice have been quite dramatic specially in Indonesia and Philippines threatened with Brown plant hopper (BPH) and Rice Tungro virus (RTC) which was transmitted by Greenleaf hopper (GLH) as a vector.

Some Success Stories

There have been success stories such as control of pests in soybeans in Brazil through various biological control agents including nuclear polyhydrosis virus (NPV) . Yet another crop where IPM has achieved success is in the area of pasture grasses specially in Latin America. Likewise application of IPM in vegetables world-wide has been highly beneficial. Success of IPM has been equally outstanding in cotton as also in sugarcane, especially in India. Cassava crop, another important food on which some 500 million people rely world-wide specially in the tropics and which is grown by the poorest of the poor, has also profited from IPM technologies.

IPM is finding its' way successfully to many crops and is now being developed for locust control apart from its application in important plantation crops like coffee and cocoa.

Excellent use has also been made in protecting ornamental, forest and shady trees, particularly by the Commonwealth Agricultural Bureaux Laboratories.

An equally hopeful development is in the area of application of IPM for control of vectors involved in human health as in case of Peru in the control of *Anopheles* sp. involved in causation of malaria. In Peru, malaria affects 16 out of every 10,000 population while in India over 2 million cases occur annually with over 1000 deaths.

IPM has thus emerged as a most cost effective weapon

in such situations. Considering the challenges such as the Great Irish Potato Famine of 1845 due to late blight or the disaster in coffee production in Sri Lanka in 1870, it is clear that strategies aimed at pesticide reduction and hopefully total elimination are both necessary and possible especially in Third World countries with low spending power, poor nutritional levels of workers and their low educational status.

Pesticide Reduction Technologies and Policies

The crux of our thrust has been to examine and evaluate the known results of studies world-wide aimed at pesticide reduction technologies whether used for farms, public health or amenities, such as public gardens, lawns, golf courses or roadsides.

And the new world is discovering the benefits of old practices such as recent findings in Germany of the plant protection powers of cow urine and dung. Thus there are new and renewed attempts, world-wide at pesticide reduction strategies in which many leading agencies have taken a pioneering part. The need and emphasis on the adoption of the whole systems approach advocated by various scientific leaders and thinkers which is now in its' third wave or stage requires social concerns. These take into account inter-country issues such as global warming, ozone depletion, acid rain apart from several other important issues that have been touched upon.

Several countries such as Denmark for instance had embarked upon pesticide reduction by 50 per cent by 1997. Similar programmes have been launched in Sweden and Holland. Sweden is particularly happy of attainment of these goals in time and is planning full steam ahead beyond 2000 AD. More recently in USA under the inspiration of Vice President Gore, IPM is expected to cover 75 per cent of the country by 2000 AD for which swift steps are underway by the USDA.

Apart from leading role played by public interest groups such as Greenpeace, Soil Association, Pesticides Trust, Food Commission and SAFE in UK, several organisations notably Pesticides Coalition, PANNA in USA and PAN- Penang and Europe and other regions of the world, have played a key role in bringing the dangers of pesticides to public and policy, makers attention and made positive proposals aimed at pesticide reduction policies and plans. Many of these issues have

been brought to pointed public attention at a Gottingen (Germany) Workshop in March, 1994.

In India a clear lead was given in this area by a Group created by the Department of Science and Technology which brought out a comprehensive, land-mark, Status Report on Alternatives to Pesticides in 1987. Unfortunately apart from this and the efforts of the Department of Biotechnology, there has been very little effective inputs from the nodal Ministry of Agriculture and their huge R&D setup, the Indian Council of Agricultural Research (ICAR) towards any positive, sustained, pragmatic and effective programmes– actions which could encourage farmers to adopt such technologies and experience. On the other hand these agencies have been literally pushing and encouraging use of pesticides through various means including subsidies. Thus the manufacture, imports including then the exports continue to be on the rise in the country.

Ecological farming in action

The AA/AS and the IPM, an intermediate towards the full goal of ecological farming(FE) and its' several variants, including natural, organic, permaculture, biodynamic etc. are today being practiced in many parts of the World successfully including India.

However, the lead in this area has been taken by farmers in USA, aided by work of various universities and the USDA/ NRC as brought out earlier. Towards finding the various important alternative technologies towards achieving the goal of farming *sans* chemicals it appears clear now that the most crucial element without off-farm inputs would be the nutrient content of the soil. This input would not be difficult to provide by traditional farming, considering the living nature of the crop, a strength that passes on to the crops giving these the necessary resistance to pests.

Hopefully the elbowing out of the chemical inputs will ensure that biodiversity, soil life, soil health are sustained and salinity, water-logging, soil erosion stopped. In this area, the pioneering work on natural farming done by Fukuoka cannot be forgotten. In all these varied systems of ecological farming, it emerges that there is a direct or indirect spiritual belief, a holistic approach or a philosophical support system. Reference has been made to the pioneering work of Sir Albert Howard who

developed, while in India, in the early 90s', the Indore compost method, leading to improved plant resistance to pests and diseases.

Such pioneering work has been followed up in UK by Lady Balfour through creation of the Soil Association by youthful followers like Charolette Mitchell. Other pioneers have been J.I. Rodale, William Abrecht, Louis Bromfield in USA. Use of technologies involving use of cover crops, green manures and rotations seem to have received new attention once again as essential ingredients of EF, leading to creation of active well knit farm families.

Reports on organic farming in six case studies (Real Dirt) in the North-east States of the USA highlight the many practical aspects of organic farming and its' feasibility. There are also reports and records of some 30 other organic ventures in these NE States.

The Energy Savings

A related question is that of heavy energy inputs needed for chemical based agriculture making heavy demands on scarce and fast depleting fossil fuels. For instance fertilizers alone account for upto 50 per cent of energy consumption in fuel. Pesticides are also energy-intensive, the organo-phosphorus (OPs) requiring about 100,000 KCal per Kg. On an average production of pesticides takes 4-5 times more energy than nitrogen fertilizer production. This apart heavy use of energy has weakened the supply position and egging on countries towards the nuclear energy an alternative that is increasingly becoming unattractive and questionable on several accounts.

It has been estimated from studies in UK, France, Germany and the USA that energy consumption would be reduced by 50% by switchback from conventional to ecological agriculture. On the basis of the data it has been inferred that ratios of direct energy input to output were 1:3 for industrial agriculture, about 1:5 for mechanised organic farms and approximately 1:11 for manual organic farms. In other words, data world-wide clearly points towards energy savings, especially when chemical fertilizers and pesticides are not used. It has also been estimated that agriculture in 1972 used about 3.5 per cent of worlds commercial energy. Nitrogen needs high energy inputs requiring in 1983-84, for 55 million tons of nitrogen, some 32 billion total gallons of diesel

fuel. On the other hand biological fixation by legumes with sunlight, produces about 88 million tons of nitrogen each year compared with chemical N- fertilizer production of about 55 million tons.

In practical terms, by switching over to organic farming Cuba has reduced petroleum product imports by 53 per cent, chemical fertilizer by 77 per cent, pesticides by about 62.5 per cent and animal feeds by another 70 per cent. This development has been hailed by the world community represented by the concerned NGOs as setting new hopes for the future.

Besides such savings, the loss of habitats and biological diversity and the extinction of species which is also the direct or indirect outcome of the present day chemical farming, is a situation that is expected to be reversed by switchover to ecological farming specially in view of the spiritual, philosophical and the whole family farming approach this entails.

There is atleast one community located in Rajasthan, the Bishnois, which is known and famous for its' regard for protection of trees which has been given a religious and a spiritual fervor an attitude which is not uncommon in many other communities around the world. Organic farmers are also attracted to the knowledge of higher nitrogen efficiency on their farms which also means reduced nutrient leaching. The promoters of organic farming are likewise enthused by the results of a 2-year study in UK, which shows higher nutritive value of fruits and vegetables such as apples and tomatoes compared to conventional farm products. Somehow the results of this study were suppressed by the UK Government authorities. There have been similar favourable reports on survival rates and improved fertility in rabbits and hens reared on organic feed apart from less albumin and more of egg yolks in hens eggs.

Likewise a Danish study reveals 2-times higher sperm count in men living on organic foods. This should be a welcome finding considering the concern on seriously reduced sperm count and decreased fertility in both men and women on account of exposure to pesticides in some European countries.

Some of the promoters of conventional farming and agrochemicals have often painted a picture of gloom and famines if organic farming was introduced. Such fears are far

from the truth, considering that the yields in organic farming by and large are not lowered except initially and the advantages from reduced and/or fast reducing essential inputs such as water, energy are far too critical.

In seems also clear that organic farming has taken roots and succeeded especially in places where it is closely linked with marketing as also certification of produce. In many countries including USA and Europe, so great is the demand that organic produce, including milk attract a far better return.

There have been a number of success stories of organic farming some of which have been briefly described here— pertaining to that of Save, Reddy and several others from India, the Bontoc terraces in Philippines and success achieved in Thailand by a group headed by Khun Samrit Boonsuk . There are several other such examples from Thailand and China, including the successes on agroforestry highlighting commercial indigenous use of some of the forest products which tend to promote agriculture in the third world. In India, groups such as Research Foundation for Science Technology and Natural Resource Policy, New Delhi, Indian Institute of Management, Ahmedabad apart from the painstaking research work involved in a publication like Tending the Earth, Bombay and the Centre for Indian Knowledge Systems group at Madras have been promoting indigenous knowledge aimed at its field application for ecological farming and revival of the accumulated ancient experience. This is not only in India but also in Sri Lanka, Bangladesh, Bhutan. Honduras, Bolivia and Zimbabwe amongst others.

Return of Botanicals

Use of plant products both for pest control in the fields and in storage also finds reference here, apart from design of storage vessels. Botanical pesticides also find an important place — some of which have been put together from India, Nepal and the Far East.

This apart reference has also been made to the sad story of vanishing and fast dwindling and extinct medicinal plants some with insecticidal power from the country apart from the problem of biopiracy and bioprospecting in the Third World.

Enter Earthworms

In the new emerging era of EF, the earthworms which earlier found an important place but were all but decimated by

chemical use, have begun to occupy an important place as was first described in 1881 by Charles Darwin himself. Without going into small controversies, whether the red earthworms are more important than the non-red ones, it seems that New Zealand scientists are possibly the pioneers in putting earthworms to practical use, on a large-scale in agriculture. There is today a commercial earthworm based bio-degradable facility of about 10 tons/day set up in Canada, which has spread far and wide and handling over 200 tons/day in USA.

There have been some institutions such as INORA and BERI in Pune and New College in Madras, which have done pioneering work in this area. However, large-scale operations have not been much in evidence despite the high potential for city waste and farm and factory wastes, use of low cost earthworm technology offers Including the Indus valley.

Returning to city farming

which unfortunately was well established in many countries including India dating back to the Indus Valley civilisation has been fast disappearing on account of various circumstances especially population pressures on land in large and metro cities coupled with switch over to the industries.

However, this seems to be returning due to the obvious benefits it offers. Apart from the advantage for conversion and utilisation of city wastes through vermicompost technology it provides nutrition at low cost to the needy and generates low cost employment. It also helps in utilization and recycling of surplus waste water. City farming specially seems to offer a splendid outlet for women's' employment and income generation.

Several examples have been cited from developing countries, where city farming is beginning to take deep roots even for migrant and displaced population. However, this could gather momentum with support from official agencies and with a little marketing support. The city farming if organised could well emerge as the nucleus of the Nutrition Garden concept which has been talked about without making much headway.

City farming could also help the growth of hydroponics or growing plants without soil, a space saving, promising system possibly using AVRDC systems developed in Taiwan which needs no external energy source and is considered viable even for rural areas in developing countries. Apart from

providing food and cash, city gardening could promote the principles of ecological farming far and wide.

Biodiversity, Bioengineering and Related Issues

That there is an increasing narrowing down of biodiversity and in some cases virtual extinction of species is no longer news. Sufficient data has accumulated on the subject starting with the almost prophetic signals which came via the Bogeve Declaration way back in 1987. Obviously such warnings have not been taken seriously. Apart from recorded losses such as medicinal plants in India, rice species in Asia, vegetables in UK, there have been reports of loss of some 20 botanical species of crops in prehistoric North America including sunflower, pancigrass, wild rice, amaranth, cranberries, tepany beans, squashes, tobacco, chilies and artichokes. The loss of such genetic resources is particularly critical and alarming for the indigenous, native and traditional people.

This highlights the need for a renewed effort to conserve native seeds (landraces) alongwith the local culture both of which are intertwined and inseparable. This approach needs also to be applied equally forcefully to indigenous forest management which fosters diversity as has been established by studies in forests of Dayak in Borneo. In this area, we must heed the call of caution sounded by scholars and crusaders in their studies on modern hybrids and genetics , biopiracy or problems of the genetically engineered seeds and products which have been coming from a few devoted groups from across the world.

This treatise briefly traces the origins of agriculture and refers to the enormous genetic diversity within wild plants left behind by our ancestors 10,000 years ago through generations. Some of these landraces (seeds) contain genetic material that modern plant breeders are using effectively. We are obviously narrowing our options for the future through reducing diversity and threatening food security and our own survival.

It seems clear therefore that conservation and full utilisation of the worlds heritage in biodiversity is the cornerstone for global food security. Rafi has done pioneering work in this area and brought out a Biodiversity Balance Sheet which has serious policy implications. The report calls for a fair balance between what it calls in-situ and ex-situ resources and technologies and harmonisation between conservation and use of resources between growing technical expertise and genius of

the indigenous people and farmers in the South.

Another area of concern is the nerbicide-resistant crop varieties and use of bioengineering for incorporating Bt genes in crops aimed at making these pest-resistant. Very strong and legitimate fears have been expressed for dangers which can have far reaching and devastating consequences for the future. These fears have been brought to the fore strongly by RAFI and the Union of Concerned Scientists in USA which just can not be wished away—fears that need to be attended to and answered to the satisfaction of all. Similar warnings have come from SAFE in UK ,GRAIN in Spain, the Edmonds Institute in USA which merit our serious attention.

There is thus need for a careful and critical study of the new transgenic crops and for assessing the risks of creating new viruses and non-target effects of pesticides. It is therefore a bit disappointing that India should have decided to import 1 million tonnes of G.E.–Soyabean from USA to feed its hungry millions But a vastly serious setback is the development of Terminator Technology by none other than Monsanto, which will shatter to smithereens all the work, hopes and dreams of the many well-wishers of this Earth. But such onslaughts should bring us all together which has become easier with the new Information Technology.

It is equally necessary that in order to meet many challenges in developmental areas specially in the Third World that we gird our lions and be ready to meet the formidable challenge. If we are to climb these New Mountains, speedily & timely, a global get togetherness would be an essential prescription to follow.

Considering the recent havoc caused by bovine spongiform encephalopathy (BSE) or mad cow disease and unforeseen problems created by antibiotics, growth stimulators and pesticides themselves and technologies such as the introduction of BST (bovine somatotropin hormone) a genetically engineered hormone in cattle and the unanticipated dangers posed by food irradiation or penicillin, it would be prudent to give cool and critical attention to the timely warnings, some of which are based on our own recent experience.

In so far as the question of safe alternatives to pesticides for ensuring sustainable agriculture is concerned, there seems to be no doubt that a speedier move towards ecological farming

is called for, irrespective of which angle we may look at it. Let us accept that there are no safe pesticides and we must ceaselessly evolve technologies for pesticide reduction and work for a day when these would no longer be needed. For ensuring adequate nutrition and energy for the worlds ever increasing hungry and deprived, it is necessary, prudent and essential that we plan not only on producing an adequate food supply at affordable prices but also ensure that this is safe and healthy and free from all contamination and additives as at present. This can only be ensured through elimination of chemicals, from food, air, soil, water, which are a cause for serious concern both for our present and future generations. And that is what sustainability is all about.

In this respect, as referred to earlier, the bold decision made in Cuba, even though based on local pragmatic necessities, to turn fully to organic farming throughout the country with totally indigenous and local inputs should serve as shot in the arm of the promoters of ecological farming world wide and hopefully it will bring around the doubting Thomases many of whom have served as stumbling block, specially at the policy and decision making infrastructure specially in the third world, of which India is a rather good and a pathetic example.

Re-inventing the Wheel?

These are some of the issues which no doubt are driving the motivated people around the world , which to an extent figured at Rio, and more recently for an in-depth look at the World Food Summit at Rome in November 1996 in the hope of finding workable, pragmatic and lasting solutions. The world was waiting with abated breath to hear of some the happy tidings from the Summit of the wise men from across the Globe. Unfortunately the reports of the Summit are not too enthusing and it seems that despite clear warnings and happenings on the food security and food safety specially from the third world, it appears that the Sumeteers were busy at re-inventing the Wheel by using an entirely diplomatic and hollow words rather than action.

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Dr. A.T. Dudani, obtained his Bachelor of Science degree from Bombay University (1945) with distinction securing the first position in Agricultural Microbiology. He obtained his Ph. D. degree from Iowa State University, Ames, Iowa, U.S.A. in 1950. He worked at the Central Drug Research Institute, Council of Scientific and Industrial Research, Lucknow (1951-54) Indian Council of Medical Research (1954-59) and Indian Council of Agricultural Research (1959-82). From 1982 onwards the author has been involved actively in public interest affairs and consumer movements. He brought out a status report on the subject in 1987 sponsored by the Department of Science & Technology which is considered a landmark report on the subject. He has research papers in national and international journals and also presented papers at various national and international seminars and meetings.

The writer has worldwide interaction with activist (pesticides and environmental) groups and he was member of several committees appointed by the Government on the subject. He has extensively written covering a wide range of subjects including global warming, chemical pollution, food irradiation, hazards of artificial steroids BST/BGH in milk etc. He is the Founder President of the Society for Citizen Concerns.